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Explaining Diversity in Fertility and Fertility Trends in English Neighbourhoods

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Research Article

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Abstract

There are relatively few spatially disaggregated studies of fertility variations and trends in developed countries, including the UK. However, knowledge on this issue is important in understanding subnational implications of reduced fertility, in terms of education and retirement provision, and labour market renewal. The present study considers varying fertility between 6856 neighbourhoods across England in 2024, and trends in fertility between 2019 and 2024. It considers the impact especially of neighbourhood urban level and socio-economic status, religious mix in different areas, and house prices and housing equity gain. It uses regression and clustering techniques – taking account of spatial concentration and autocorrelation - and finds all these factors to be important in explaining cross-sectional and trend variations. Contextual effects are apparent in varying effects of urban level on fertility trends, and in regional contrasts in fertility trends between ethno-religious groups.

1 Introduction

There are many national level studies of changing fertility (Berrington et al, 2023; Kulu et al, 2026) across developed countries. However, there are few spatially disaggregated studies of fertility variations and trends (Kulu and Boyle, 2009), especially in contrast to considerable number of small area studies of health and mortality. The latter research shows that place effects on health are considerable (Macintyre et al, 2002), with potential relevance to small area fertility.

Knowledge on fertility trends both nationally and at lower spatial scales is important in understanding the widespread trend to reduced fertility, with its implications for education provision, labour market age structures, and provision for older age groups (UK House of Lords, 2026). It should be noted that there was a rebound in UK fertility in the 2000s, arguably due to family friendly policies (Hoorens et al, 2011), but since then a continuous decline, with the UK's total fertility rate falling from 1.91 in 2012 to 1.65 in 2019 and 1.40 in 2024 (Office of National Statistics, 2026a).

The extent of geographic diversity in fertility between smaller neighbourhoods in the UK, and reasons for such diversity, are largely unexplored. This applies especially to studies of fertility trends in the UK.

One of few sub-national studies for the UK is by Kulu and Washbrook (2014), albeit cross-sectional, involving spatial aggregates (smaller vs larger towns), and for 2011. For European countries, one may cite the research by Kulu and Boyle (2009), Sobotka and Adigüzel (2002), Campisi et al (2020), Vitali and Billari (2017), Kurek (2026), Carioli et al (2021), and Riederer and Beaujouan (2024); and for non-European settings, the research of Hu et al (2025a, b).

Regarding European fertility, Kulu and Boyle (2009) confirm the lack of sub-national, let alone neighbourhood, studies of fertility variation, opining that "[it is] remarkable that so little research has explored fertility variations within nations". Of the available studies, most simply consider variations by large spatial units, or broad urban category (e.g. Ohlsson-Wijk and Andersson, 2022; Kulu and Washbrook, 2014; Kulu and Washbrook, 2014).

The present study considers varying fertility in 2024 between 6856 neighbourhoods across England (census areas denoted Middle Level Super Output Areas, MSOAs), and trends in fertility in MSOAs between 2019 and 2024. These have an average population of 8500, and are likely to be more internally homogeneous in their socio-demography and contextual features than the spatial levels used in previous geographically oriented studies of fertility. In this regard Pinzari et al (2018) argue that "for detecting the variation of health indicators across similar areas or peer geographies is often useful, if the spatial units are socially and economically meaningful, so that there is a degree of homogeneity in each unit".

By contrast, even relatively recent studies of spatial fertility variation consider large spatial units in population terms. Thus, Vitali and Billari (2017) consider trends at the province level in Italy (i.e. for 110 provinces, averaging 0.5 million population), while Kurek (2026) studies Polish counties averaging 100,000 population, and Carioli et al (2021) also use comarcas averaging 100,000 population, but varying greatly in size. The Netherlands study by Sobotka and Adigüzel (2002) uses relatively large commuting regions, which they recognize as internally heterogeneous. The Chinese study by Hu et al (2025a) uses counties averaging 0.5 million population, while the study of Basten et al (2011), while recognizing the gains from socio-geographical analysis of fertility, uses European NUTS regions, which even at NUT-3 level average around 0.4 million population.

Our analysis considers the impact on neighbourhood fertility and fertility change of urban level, socio-economic status, religious mix, house prices and housing equity. It uses regression and cluster analysis techniques, adjusted for spatial correlation (Bergsvik et al, 2023; Kurek, 2026; Carioli et al, 2021), and finds all of these factors to be important in explaining cross-sectional and trend variations. Contextual effects are apparent in varying effects of urban level on fertility trends, and in regional contrasts in fertility trends between ethno-religious groups.

1.1 Novelty

The novelty of the present study is found in the following aspects: (a) in a clear neighbourhood focus, as distinct from comparing broad urban categories (e.g. towns grouped into size categories, or suburbs vs inner cities), or large regions - this is important as variation within broad categories may well be considerable; moreover, smaller spatial units are likely to be more internally homogeneous in their socio-demography (Pinzari et al, 2018) (b) in studying subnational trends in fertility - existing evidence on subnational fertility in the UK is the subject of few studies, and these are confined to cross-sectional variations; (c) in controlling for and assessing the role of unobserved spatially clustered influences on fertility, including delineating spatial fertility regimes; (d) in considering fertility impacts of small area religious composition, previously not studied; (e) in considering impacts on fertility of small area house prices and housing equity gain.

2. Available Evidence on Sub-National Fertility Variations, and Gaps in Existing Research

As mentioned above, our study considers the impact on fertility variations and change of urban level, socio-economic status, religious mix, house prices and housing equity gain. Existing evidence on subnational fertility in the UK, is the subject of few studies, and these are confined to cross-sectional variations.

2.1 Urban Level

Thus, the impact of urban level on fertility is relatively well studied, especially contrasts between larger and small towns, and between suburbs and inner cities. Kulu and Boyle (2009) report that “those few recent studies which have examined contemporary geographical fertility variations within countries […] tended to focus on broad urban-rural differences, with the overriding conclusion being that fertility rates are significantly lower in urban or metropolitan areas”.

Kulu and Washbrook (2014, section 2) suggest that this may reflect the location of lower fertility groups, for example, higher income groups and students, in more urban areas, and higher familism in less urban settings. Familism, following Timms (1971), is characterised by residential stability and higher concentrations of family and married households as against relatively transient non-family households. Pursuing the same theme, Kulu and Boyle study (2009) contrast higher suburban fertility to inner city birth rates, while Kulu and Washbrook (2014) contrast lower fertility in larger towns as compared to small towns.

As well as higher familism in less urban settings, other influences may well be present, such as less urban environments being more child friendly, with less traffic, more play opportunities and so on (Gill, 2021; Cordero-Vinueza et al, 2023). Neighbourhood cohesion (e.g. feelings of trust and belongingness), which may impact fertility, is also higher in less urban settings (Buh et al, 2026; Buckner, 1988).

Existing research on urbanicity effects has not studied the full range of urban environments in relation to fertility, from remote rural to densely populated inner city, or considered diversity in fertility experience within broad categories. For example, as our research below shows, a substantial minority of neighbourhoods have increased fertility over the period studied; and urban areas in some English regions have maintained fertility, while others show large falls.

2.2 Area Socio-economic Status

Regarding socio-economic status (SES), including that of neighbourhoods, the historic differential is for higher fertility in lower SES groups and in more deprived areas. This applies especially to fertility at lower ages (under 30) and teenage births (Ermisch, 2023).

However, recent trends towards reduced fertility may not reproduce this differential, and may run counter to it. Thus, the Centre for Progressive Policy (2024) reports “a 10% higher annual rate of fertility decline in deprived [UK] areas than their affluent

counterparts".

2.4 House Prices

Regarding housing availability and affordability, there are considerable variations between different parts of the UK and England that are likely to impact on family rearing and family size choices, especially in relation to varying incomes between regions and neighbourhoods, and especially for couples not currently owning their house. Aksoy (2016) reports a deterrent impact of high house prices on fertility using data for English counties, Beck (2026) reports such an impact of high housing costs in London, while Weiwei and Pu (2026) document the same effect in large Chinese cities.

However, the impact of house prices is not as straightforward as at first sight, as mentioned by Houillion et al (2026) in a study of the 32 London Boroughs (large spatial units averaging around 290,000 population). They report that the anticipated negative effect of higher house prices on fertility is reversed in better off areas with high owner occupancy, as "increases in house prices are found to increase fertility rates, due to positive wealth effects that accrue to existing homeowners". This equity gain effect is also mentioned by Dettling and Kearney (2014) in a study of US Metropolitan Areas. They report that "a $10,000 increase [in house prices] leads to a 5 percent increase in fertility rates among owners and a 2.4 percent decrease among nonowners".

Neither of these studies of house price effects consider a full range of urban-rural environments, only more metropolitan settings.

2.5 Ethno-Religious Differences

Regarding ethnic and religious influences on fertility, these are important for a spatial analysis because of residential clustering by ethno-religious category (Harris, 2024). We analyse recent ethnic fertility contrasts and changes between 2011 and 2021, confirming higher fertility in groups with high Muslim adherence, but also convergence between groups (cf. Kulu and Hanneman, 2016; Dubuc, 2009).

In regression modelling, however, we focus on neighbourhood religious mix as it is potentially more revealing of fertility heterogeneity within ethnic groups. For example, among white groups, fertility choices may differ between Christians and non-believers (Yancey and Emerson, 2018; Philipov and Berghammer, 2007). Higher fertility among Muslim groups is well documented, as is a tendency to fertility convergence over time (Westoff and Frejka, 2007).

Impacts on fertility of spatially varying religious mix between neighbourhoods have not been considered in previous UK studies.

3. Contextual vs Compositional Interpretations

Neighbourhood or place effects have distinguished between compositional effects, inherently reflecting the socio-demography of the local population, as against contextual effects from environmental influences. In alternative terms, Deryugina and Molitor (2021) state that "geographic variation in [neighbourhood health outcomes] could be due to non-random geographic sorting of individuals, with geographic differences reflecting the exogenous characteristics of residents. Second, place of residence could have a causal effect [..] through a variety of channels, which may operate through largely immutable local characteristics (like climate in that area) or through characteristics amenable to policy (like the local health care system or exposure to pollution)".

Other features, such as spatial spillover of environmental influences (e.g. house price trends, pollution, crime) are distinct from compositional effects, which are inherently an effect of the local socio-demography of a neighbourhood on the outcome of that neighbourhood. A contextual effect from environmental influences is typically spatially unbounded in impact, spilling over administrative boundaries.

Contextual effects are also likely to be relevant to sharply contrasting effects of compositional variables between regions; for example, if the effect of a particular neighbourhood religious mix (e.g. percent Muslim) varies between spatial contexts.

The question of contextual as against compositional influences on subnational fertility was raised by Kulu and Boyle (2009), who focus on fertility contrasts between (central) urban areas as against suburban and rural areas. They find much of this contrast to reflect familism, which can be seen as primarily compositional. However, they also pointed to the influence of varying dwelling mix, interpretable as contextual, mentioning that "most couples in the suburbs and rural areas are more likely to live in single-family houses and couples in urban centres are more likely to live in flats".

Our work here is novel in considering the impact on fertility of house price variations, which can be seen as a contextual influence, reflecting localised patterns of dwelling mix, land supply, housing supply and demand, and preferred place characteristics, such as parental perception of child friendliness (Gong et al, 2025), suitable school locations, green space access and so on. The complex spatial nature of house price dynamics, including spatial spillovers, is documented by Cohen et al (2016).

The delimitation of contextual as against compositional influences is rather fuzzy, and not (so far as the authors are aware) considered in the literature. For example, does compositional apply only to people characteristics, or also to housing characteristics, such as tenure mix. If it does extend to housing characteristics, then the consideration in the present study of interactions between owner occupancy and house price changes amounts to considering interactions between context and composition - again a topic not considered so far in the literature.

More clearly compositional influences considered in this study are those due to socio-economic structure, and ethno-religious mix. However, even these features may interact with local labour demand and housing mix and market factors. The equity gain effect mentioned above may be more likely among higher income and SES groups.

4. Methods

4.1 Fertility Metric

To assess small area variations in fertility we consider general fertility ratios (GFRs) in 2024 for 6856 neighbourhoods (census units denoted Middle Level Super Output Areas, MSOAs), using annual birth data from the Office of National Statistics (ONS) nomis page (https://www.nomisweb.co.uk/). GFRs (per 1000) are births divided by female populations (ages 15–49), as provided by ONS (2025b). For assessing trends, we use differences between GFRs in 2024 and in 2019, providing a readily interpretable metric. Available data for MSOAs do not contain detail on maternal age, but approximate total fertility rates (TFRs), based on GFRs, can be obtained analytically using the methods of Hauer et al (2013).

Total fertility ratios are an alternative summary index of fertility and analogous in their calculation to directly age standardised rates of mortality or disease incidence. The released data at nomis do not allow derivation of TFRs at MSOA level. General fertility ratios only standardise for the size of the total female population of reproductive age, but seem to provide a close approximation to TFRs. At local authority level (there are 296 of these large administrative areas across England), the nomis site provides both GFRs and TFRs in 2024, and GFRs correlate 0.962 with TFRs. As would be expected, crude birth rates are a much less good approximation, correlating only 0.516 with TFRs.

However, as a further cross-check against use of general fertility ratios, we use an indirect age standardisation approach at MSOA level for analysing cross sectional variation (see Appendix 1). This provides what we term Standardised Fertility Ratios, which when calculated at local authority level, correlate 0.980 with TFRs. Subsequently, we apply spatial regression (see section 4.4) using both (a) spatial linear regression of GFRs and (b) spatial negative binomial regression of birth counts, with expected births as an offset, consistent with indirect age standardisation (Clayton and Kaldor, 1987).

4.2 Fertility according to Broad Place Categories

We first present fertility and fertility change summaries over the nine England standard regions, and by broad urban-rural category, namely the 2021 Rural Urban Classification (Office of National Statistics, 2026c). In seeking to explain the variation apparent in these subnational categories, we then assess gradients in fertility and changed fertility according to measures of the socio-demographic factors discussed in the previous section, before accounting for their joint effect via regression.

4.3 Gradients in Fertility by Socio-Demographic Indicators

We accordingly consider gradients in GFRs and changed GFR according to quintile groups of the main predictors used (e.g. area SES, urbanicity, etc). Apart from MSOA house price and income information, predictor data are from the 2021 Census (see Appendix 2 for details). House price information is used in two ways. We first consider affordability (house prices in 2023 divided by incomes in 2023), expected to be relevant to GFR comparison in 2024. Second, we consider the interaction between owner occupancy (2021 Census) and house prices increases (from 2018 to 2023), as a proxy for the “equity gain effect” expected to be most relevant to GFR trends. A similar interaction variable is used by Dettling and Kearney (2014).

We consider fertility profiles across neighbourhood religious mix, specifically four types of adherence: Muslim, Christian, no religion, and Hindu/Sikh. Religion and ethnicity are interrelated in the UK, and these adherence profiles are complemented by a comparison (for 2011 and 2021) of actual against expected births by ethnic group, as a method of indirect age standardisation (see Appendix 1). Expected births are obtained using a standard national set of birth rates, specific to age bands 15–19, 20–24 through to 45–49. To enable comparison of fertility levels over time, we use rates for a single year (2021) as standard. This provides indirectly standardised fertility ratios (SFRs), exactly analogous to indirect standardisation for health events (mortality, cancer incidence, etc). These SFRs pertain to live births only.

4.4 Spatial Regression

Fertility profiling against a single factor such as urbanicity, or proportions not religious, does not adjust for the interplay between predictors, or for unobserved spatially clustered influences on fertility (Bergsvik et al, 2023). These influences are likely to operate at disaggregated spatial scales, as we adopt in the current study, namely MSOAs, averaging 8500 population, the advantages of which over much larger units are referred to above. As Hu et al (2025a, page 2) mention, residual spatial effects may reflect unmeasured contextual influences, as neighbourhoods close in space have similar context, and may be subject to overspill of such context effects.

We use regression techniques adjusted for spatial clustering, and applied via the R INLA packages. We use the spatial random error proposed by Riebler et al (2016) and illustrated by Konstantinoudis (2026); this allows a mix of spatially structured variation and simple heterogeneity. The proportion of variation that is spatially structured indicates the extent of spatial clustering in unmeasured contextual and compositional influences on fertility. An additional aspect of the regression is that predictors are converted to a [0,1] scale (0 = minimum, 1 = maximum on the transformed scale), so that their impacts can be compared.

Our main analysis is based on general fertility rates, but in Appendix 3, we consider explanation of fertility variation in 2024 using spatial negative binomial regression, and assess comparability with results from spatial linear regression of GFRs. This approach is closely comparable to disease mapping methods, typically Bayesian, which use expected disease cases as an offset, to provide indirect age standardisation, a seminal reference being Clayton and Kaldor (1987). In disease mapping with event counts, the regression is typically Poisson or negative binomial, with a log link, and exponentiated coefficients represent relative risks of the event being considered.

4.5 Spatial Regression Predictors

For religion, we focus in the regression on the impacts of MSOA proportions Muslim (6.7% of England's population) and without religion (36.7% of the total). We anticipate, based on the profile analysis and previous evidence of religious impacts on fertility, that these two categories will be more important influences.

For studying the impact of housing equity gain on changing fertility, we consider an extended interaction, namely between area SES, owner occupancy and house price gain. Higher area SES and higher owner occupancy are closely interrelated and the house equity gain effect may be stronger for higher SES groups.

To anticipate later findings, we confirm all these factors just mentioned (area SES, religious mix, house price variation and equity gain, and urban level) to play a part in explaining cross-sectional fertility and trend variations.

4.6 Cluster Profiles and Spatial Regimes

Regression may be affected by including too many correlated predictors (such as, in the UK, ethnic and religious categories), with the risk of multicollinearity. An illustration of the potential impacts of this – in terms of effects contrary to substantive expectations – is provided by Hu et al (2025a, page 10) who find an unexpected positive impact of population density (a proxy for urban development) on fertility.

A flexible strategy less open to distortion from feature overlap is provided by cluster analysis, especially if spatial clustering of fertility and its influencing factors is allowed for in the analysis. A spatially adjusted cluster analysis is suited to detecting particular spatial fertility regimes, applicable in other contexts (e.g. Ertur et al, 2006). A plausible spatial fertility regime would show (a) similar patterns of fertility and fertility change, (b) similar spatial location, and (c) similar socio-demography. An analogous approach is

pursued by Kurek et al (2021). This form of clustering is additionally tuned to detect spatial heterogeneity and interactions between influences on fertility.

We use the R package ClustGeo which uses hierarchical clustering subject to spatial constraints. A tuning parameter is chosen to provide high intra-cluster homogeneity in both area sociodemographic characteristics, and cluster spatial concentration (Chavent et al, 2018). Preliminary assessment based on 10 clusters shows a tuning parameter of 0.3, as suitable in this regard.

This analysis includes two indicators not used in the regression because of high correlations with the urbanicity scale: the social fragmentation index (Whitley et al, 1999), and the proportion of dwellings consisting of flats. The fragmentation index serves both as a proxy for neighbourhood cohesion and as an inverse measure of familism, as it includes proportions of household heads not married, population turnover, and single person households.

We apply this approach to assess which areas show fertility gain despite an overall downward trend, and use two binary indicators of fertility gain as input variables: first, a code of 1 if the MSOA is in the top octile (top 12.5%) of fertility gains (GFR differences between 2024 and 2019), and 0 otherwise; and second, an exactly analogous indicator according as the MSOA is in the top quartile of fertility gains or not. The other input variables to the cluster analysis retain the [0,1] scale used in the regressions.

5. Findings

5.1 Urban and Regional Categories

Table 1 shows the most marked fertility declines in the most urban categories, and lesser declines in the “smaller rural” categories. To illustrate trend diversity, in the “smaller rural: nearer major town/city” category, 40% of MSOAs have seen increased fertility, compared to only a fifth of MSOAs in the two most urban categories. Regarding regional contrasts, fertility has declined most in London, which had the highest GFR in 2019, but the fourth highest in 2024. Fertility has also declined in South West England. All regions apart from these have subsets of areas with fertility growth accounting for at least a fifth of the region total of MSOAs, reaching around 30% in North East England and the West Midlands.

Table 1
Fertility Differentials and Trends by Region & Urban Category

Region	GFR 2019	GFR 2024	Difference in GFRs	% MSOAs where GFR increased
East Midlands	47.0	41.1	-5.9	25
East of England	51.0	44.1	-6.9	22
London	51.3	42.6	-8.7	13
North East	45.2	40.5	-4.7	28
North West	49.8	43.0	-6.8	23
South East	47.6	41.6	-6.0	24
South West	45.9	38.2	-7.7	18
West Midlands	50.7	46.8	-3.9	31
Yorkshire/Humberside	48.3	43.0	-5.2	26
Urban Category				
Larger rural: further from major town/city	45.8	40.5	-5.3	29
Larger rural: nearer major town/city	47.1	42.6	-4.5	31
Smaller rural: further from major town/city	42.1	39.1	-3.0	33
Smaller rural: nearer major town/city	43.1	40.7	-2.4	40
Urban: further from major town/city	48.6	41.2	-7.3	19
Urban: nearer to major town/city	49.7	42.8	-6.9	21
England	49.0	42.5	-6.5	23

5.2 Gradients in Fertility and Fertility Change by Socio-Economic Indicators

Table 2A shows fertility and trends according to quintile categories of MSOA socioeconomic status, urbanicity, and two house price based indicators. The first is affordability category (house prices divided in 2023 by incomes in 2023), while the second is the interaction between owner occupancy (2021 Census) and house prices increases (from 2018 to 2023).

It can be seen from the first subpanel that fertility has fallen least in higher SES neighbourhoods, with the GFR gap between the highest and lowest SES quintile category falling from 14.4 in 2019 (57.1 as against 42.7) to 10.8 five years later.

The second subpanel confirms Table 1 in showing that highly urban areas have seen the greatest decline in fertility, though there is a slight nonlinearity in that the most urban areas have a lesser fertility decline than those in the fourth quintile. We explore the possible compositional nature of this in the cluster analysis below.

The third subpanel shows that areas with greater affordability (in the lowest quintile of house price to income ratios) have the highest fertility in 2024. However, affordability does not show a consistent gradient with regard to fertility trends between 2019 and 2024.

By contrast, the equity gain effect, taking account of owner occupancy levels and house price increases in combination, shows greatest increases in equity gain to be associated with the lowest falls in fertility. A third of MSOAs in the highest equity growth category have increased fertility between 2019 and 2024 compared to the England average of 23%.

Table 2
A Differentials and Trends in GFR, Socio-Geographic Indicators

Quintile Groupings of MSOAs (Quintile 1 Lowest Levels)				
Neighbourhood SES, Quintile	GFR 2019	GFR 2024	Difference in GFRs	% MSOAs with GFR increases
1	57.1	48.8	-8.2	18
2	50.6	42.8	-7.8	17
3	47.0	40.6	-6.4	22
4	46.1	40.8	-5.3	28
5	42.7	38.0	-4.6	29
England	49.0	42.5	-6.5	23
Urbanicity, Quintile				
1	44.3	40.7	-3.6	34
2	46.8	41.5	-5.3	25
3	50.4	43.1	-7.3	19
4	52.7	44.1	-8.5	16
5	49.4	42.5	-6.9	19
England	49.0	42.5	-6.5	23
House Price to Income Ratio, Quintile				
1	50.6	44.6	-6.0	23
2	49.6	43.3	-6.3	24
3	49.4	42.6	-6.8	20
4	49.9	42.8	-7.1	21
5	45.3	38.9	-6.4	25
England	49.0	42.5	-6.5	23
Interaction between Owner Occupancy and House Price Increase, Quintile				
1	47.6	40.5	-7.1	18
2	54.0	45.2	-8.7	15
3	50.2	43.7	-6.5	20
4	47.6	42.2	-5.4	26
5	44.9	41.1	-3.8	34
England	49.0	42.5	-6.5	23

5.3 Gradients in Fertility and Fertility Change by Neighbourhood Religious Adherence

Table 2B compares neighbourhoods according to the main religious categories in England (with 46% population identifying as Christian, 37% no religion, Muslim 7%, and Hindu/Sikh 2.5%). The GFRs refer to total births divided by total MSOA female populations aged 15–49, but can indicate the influence of neighbourhood religious composition when particular religious subgroups form a high proportion of neighbourhood populations.

In the fifth quintile of neighbourhood percentage Muslim, 23% of populations are Muslim. The GFR in 2024 in this quintile is elevated compared to the overall England fertility, with respective GFRs of 46.5 and 42.5. However, this quintile shows a larger fall in GFR between 2019-24 than across England as a whole (by 7.2 vs 6.5). This complements the analysis of Appendix 1, which shows convergence in standardised fertility ratios for Pakistani and Bangladeshi subpopulations (which both have over 90% Muslim adherence) towards the overall population level.

This convergence is however spatially heterogenous. Large falls in fertility occurred in London boroughs with large Muslim populations, such as Newham, where the GFR fell from 63 to 50 in the period 2019-24, as well as Redbridge and Brent. Areas in the fifth quintile of Muslim concentration which are also in London show an average GFR difference (2024 minus 2019) of -10. This compares to -2.5 for areas in this quintile located in the West Midlands, and – 4.9 in Yorkshire-Humberside, two regions outside London containing cities with high Muslim concentrations (Muslim Council of Britain, 2026) – see Fig. 1.

A striking fertility contrast associated with neighbourhood religious mix is for Census respondents saying they followed no religion. In MSOAs with the highest proportions following no religion (49% in the top quintile), the GFR is 38.7. There is a clear downward gradient in fertility and fertility growth as the extent of non-religion increases, and only 16% of MSOAs show increased GFR in the least religious quintile.

Fertility is relatively high in areas with high Hindu/Sikh adherence, but changes in fertility show no clear pattern for this group. Fertility change also shows no clear pattern with regard to neighbourhood levels of Christian adherence.

Table 2
B Differentials and Trends in GFR by Major Religious Groupings

Quintile Groupings of MSOAs (Quintile 1 Lowest Levels)				
Muslim Adherence, Quintile	GFR 2019	GFR 2024	Difference in GFRs	% MSOAs where GFR increased
1	44.9	40.2	-4.6	29
2	48.3	42.4	-5.9	27
3	48.2	41.2	-6.9	20
4	47.9	40.5	-7.4	18
5	53.7	46.5	-7.2	19
England	49.0	42.5	-6.5	23
Christian Adherence, Quintile				
1	44.8	40.8	-4.0	21
2	51.1	43.4	-7.6	15
3	52.1	43.7	-8.4	19
4	48.2	42.2	-6.0	24
5	47.9	42.0	-5.9	34
England	49.0	42.5	-6.5	23
No Religion, Quintile				
1	56.1	48.8	-7.3	22
2	47.5	41.8	-5.7	27
3	46.5	40.8	-5.7	26
4	47.8	41.4	-6.4	22
5	46.2	38.7	-7.4	16
England	49.0	42.5	-6.5	23
Hundu/Sikh Adherence, Quintile				
1	46.7	40.9	-5.9	28
2	48.9	42.7	-6.2	23
3	48.9	42.4	-6.5	22
4	47.9	40.8	-7.0	20
5	51.9	45.1	-6.8	21
England	49.0	42.5	-6.5	23

5.4 Regression Findings

Table 3 summarises results of linear spatial regression with included predictors based on results in Table 2. To mitigate against possible multicollinearity on using all religious categories as predictors, we include Muslim and non-religious adherence, which have the most consistent influence on fertility and changed fertility in section 5.3.

Table 3
Regressions for MSOA Fertility

A. Variations in 2024 at MSOA level, Estimated Coefficents				
	Coefficient	**St Devn**	**2.5%**	**97.5%**
Intercept	65.25	1.64	62.02	68.47
Socioeconomic Status	-17.90	0.99	-19.84	-15.97
Urbanicity	-12.90	1.91	-16.64	-9.15
Muslim Adherence	11.21	1.70	7.88	14.55
No Religious Adherence	-11.19	1.47	-14.07	-8.31
Ratio House Prices to Incomes	-20.38	2.31	-24.92	-15.85
East of England	3.48	1.17	1.18	5.77
London	1.36	1.21	-1.02	3.73
North East	-1.27	1.68	-4.56	2.02
North West	1.15	1.20	-1.21	3.50
South East	3.01	1.12	0.82	5.20
South West	0.24	1.33	-2.36	2.84
West Midlands	1.77	1.13	-0.44	3.99
Yorkshire/Humberside	0.39	1.14	-1.84	2.62
% Residual Variation Spatially Structured	56%			
B. Change in GFR at MSOA Level, Estimated Coefficents				
	Coefficient	St Devn	2.5%	97.5%
Intercept	-10.61	1.57	-13.69	-7.52
Socioeconomic Status	12.93	1.02	10.93	14.93
Urbanicity	-4.16	1.93	-7.93	-0.38
Muslim Adherence	3.52	1.65	0.29	6.75
No Religious Adherence	-5.12	1.42	-7.90	-2.34
Equity Growth Index	1.51	1.07	-0.59	3.61
East of England	-1.51	0.97	-3.42	0.39
London	-2.70	1.05	-4.76	-0.65
North East	2.11	1.41	-0.65	4.87
North West	-1.09	1.01	-3.06	0.88
South East	-1.09	0.95	-2.96	0.77
South West	-1.41	1.14	-3.65	0.82
West Midlands	1.50	0.91	-0.30	3.29
Yorkshire/Humberside	0.79	0.94	-1.05	2.62
% Residual Variation Spatially Structured	60%			
C. Change in GFR at MSOA Level, Alternative Equity Gain Measure, Estimated Coefficents				

A. Variations in 2024 at MSOA level, Estimated Coefficents				
	Coefficient	**St Devn**	**2.5%**	**97.5%**
	Coefficient	St Devn	2.5%	97.5%
Intercept	-10.51	1.43	-13.32	-7.70
Socioeconomic Status	11.22	1.33	8.60	13.83
Urbanicity	-3.61	1.93	-7.38	0.17
Muslim Adherence	3.79	1.64	0.58	6.99
No Religious Adherence	-4.60	1.42	-7.39	-1.83
Extended Equity Growth Index	3.77	1.63	0.57	6.96
East of England	-1.41	0.95	-3.28	0.45
London	-2.58	1.03	-4.60	-0.56
North East	2.16	1.38	-0.55	4.86
North West	-1.07	0.99	-3.00	0.87
South East	-0.98	0.93	-2.81	0.85
South West	-1.35	1.12	-3.55	0.85
West Midlands	1.57	0.89	-0.19	3.32
Yorkshire/Humberside	0.78	0.92	-1.02	2.57
% Residual Variation Spatially Structured	67%			

5.4.1 Regression Evidence regarding Fertility Contrasts in 2024

With regard to cross-sectional fertility variations in 2024 (upper sub-panel of Table 3), the two most important influences are socio-neighbourhood economic status (namely higher fertility predicted in lesser status areas), and housing affordability (higher fertility in the most affordable areas).

The effects of the two religious adherence variables are in line with the results from Table 2B. Higher TFRs are associated with proportion Muslim, with GFRs predicted to be 11 points higher comparing MSOAs with the minimum and maximum Muslim proportions. By contrast, GFRs are 11 points lower comparing MSOAs with the minimum and maximum proportions not religious.

Higher urbanicity is significantly associated with lower fertility. Compared to other regions, fertility is slightly higher in Eastern and South Eastern England (note, the latter excludes Greater London).

5.4.2 Regression for Fertility Change

Socioeconomic status is also the most important influence on fertility change between 2019 and 2024, but in a direction against historical patterns, with more fertility gains (and lower declines) in higher status areas. This implies a convergence in fertility between socioeconomic groups – parallel to the convergence between ethno-religious groups.

The equity gain effect (the interaction between owner occupancy and house price increases) is positive, as expected, but relatively small, with 95% interval inconclusive. However, using the extended interaction between SES, owner occupancy and house price increase does show a significant effect (see third subpanel of Table 3).

Fertility losses are greater in areas with more people adhering to no religion, and less in areas with large Muslim populations. We elaborate on these aspects in the subsequent cluster analysis.

5.5 Cluster Analysis: A Focus on Neighbourhoods with Increased Fertility and Spatial Fertility Regimes

It is of interest to delineate the characteristics of small areas which “buck the trend”, showing increased fertility despite the overall decline between 2019 and 2024, and potentially defining spatial fertility regimes.

Table 4 shows results from the spatially constrained regression, so that clear spatial concentrations are apparent. Note that ethnic and religious categories are on the [0,1] minimum-maximum scale, and are not population proportions.

Table 4 shows three of the ten clusters (clusters 4, 6 and 7) with above average concentrations of neighbourhoods with fertility gain. Two of these (clusters 4 and 6) have predominantly white populations, relatively high neighbourhood SES, and a non-urban focus. Cluster 4 is concentrated in the South of England, while cluster 6 shows a mostly Northern location. These clusters respectively account for 18.4%, and 4.6% of all English MSOAs.

The regional and non-urban location of these two clusters may be tied to differences in housing affordability and housing equity gain in the mid-2020s. Greater affordability in South East areas outside London is reported by Mortgage Introducer (2025), while the discussion by Harvey (2024) shows how lower mortgage costs, combined with house price inflation, are a distinct feature of the housing market in Northern England.

Figures 2 and 3 show all MSOAs in northern England (the North West and North East standard regions combined) in terms of fertility change and urbanicity; both Figures have quintile cut-points. Figure 3 highlights metropolitan areas: Manchester and Liverpool in the SW portion of the map, and Tyneside and Teeside in the NE portion of the map. Figure 2 shows fertility increases in less urban areas as clearly apparent, whereas the largest fertility declines, namely GFR declines of over 14 per 1000, are concentrated in the most urban settings. However, some urban areas maintain their fertility.

in Northern England MSOAs

The other cluster with relatively stable fertility, cluster 7, presents a considerable contrast to the other two: it is highly urban, with whites a minority (around a quarter of the population), over half the population of Pakistani or Bangladeshi ethnicity, and high levels of Muslim adherence. Neighbourhood SES is the lowest of all the clusters. This cluster accounts for 2.5% of all MSOAs, and is concentrated in the North and West Midlands, with particular concentrations in Birmingham and Bradford, two of the five English locales with highest Muslim concentration identified by Muslim Council of Britain (2026).

Clusters 1,2, and 3 exemplify urban areas with fertility decline, but show varying socio-demographic profiles. Cluster 1 is especially inner city and London focused, evidenced by high levels of flatted housing, and also has large black and mixed communities. Cluster 2 is more ethnically diverse, though with low levels of Muslim or Hindu-Sikh adherence, while cluster 3, concentrated in London, has around a third of the population with Muslim adherence, and around three quarters with south Asian ethnicity. So cluster 3 demonstrates both south Asian fertility convergence, and the varying paths of Muslim fertility according to region.

Cluster 10 shows trends at variance with most other clusters: with fertility decline, but a non-urban bias. It is concentrated in southern England (especially the south west), with high levels of non-religion and a bias to white ethnicity. This cluster may be taken as an indication of fertility divergence within the white population, though more research is needed to establish its character, and its family culture (e.g. career oriented vs traditional familistic). Such divergency can be set against converging non-white ethnic fertility to the overall average (see Appendix 1), and narrowing differences between neighbourhoods according to area SES.

Discussion

We propose four central messages from the analysis presented above. The first is the gain from undertaking spatially disaggregated analysis of fertility to neighbourhood level, going beyond existing studies which are limited to broad spatial categories. In fact, no recent spatially disaggregated studies of UK fertility or fertility trends (to small area or neighbourhood) are known to the authors.

We show first, that pronounced fertility decline in metropolitan and highly urban settings is offset by relatively stable or increased fertility in less urban settings, though there is diversity within these broad categories. Thus the most marked fertility decline is in London, and less apparent in urban areas of northern and middle England. Second, we find a significant minority of MSOAs show a gain in fertility over the five-year period studied. Third, we show impacts of neighbourhood religious mix on fertility and fertility trends, a little studied aspect of spatial fertility differences – though see Sobotka and Adigüzel (2002). Fourth, we show the spatial heterogeneity in Muslim fertility convergence, with more stable Muslim fertility in Northern and middle England.

The second message is the gain from spatially oriented methods to allow, for example, delineation of spatial regimes with varying fertility declines via spatially constrained cluster analysis. For instance, the most convincingly high fertility growth cluster (cluster 6 in Table 4) is concentrated in Northern and Midland regions of England, and is oriented to higher SES non-urban areas in these regions. Reasons for this may involve regional variation in housing affordability and costs but await further research. Another distinct regime shows continuing high fertility in areas with large Muslim populations, and is concentrated in the West Midlands and North (cluster 7 in Table 4), whereas London areas with large Muslim communities have seen considerable fertility falls, examples including Newham and Tower Hamlets (cluster 3 in Table 4).

The third is the relevance of the current study to discussions of fertility dynamics in the UK. The Pew Research Centre (2011) forecast considerable growth in the UK Muslim population, reaching 8.2% of the total by 2030, based on immigration patterns, a younger age profile, and higher fertility rates. This compares to 6.5% in the 2021 Census, up from 4.9% in the 2011 Census.

We find here a more nuanced picture: first, there is evidence that ethnic groups with highest Muslim adherence (Pakistanis, Bangladeshis) show converging fertility towards the overall average (e.g. see Appendix 1). In fact, the fertility decline in ethnic groups with highest Muslim adherence is higher than for white groups. Similarly, Table 2B shows downward fertility in areas with highest Muslim concentrations.

Secondly, in terms of neighbourhood trends, as summarised in certain of the spatial regimes of Table 4, we find many predominantly white neighbourhoods, especially in less urban settings with owner occupied housing, show stable or growing fertility.

The fourth message relates to the relevance of the contextual vs compositional distinction to neighbourhood fertility and fertility change. Influences such as area SES and ethno-religious mix can be seen as primarily compositional. But environmental context (place effects) are considerable.

One illustration of this is that Muslim urban concentrations in midland and northern regions of England mostly maintain high fertility between 2019 and 2024, whereas London areas with Muslim concentrations show considerable fertility decline – maybe reflecting housing and childcare costs (South West Londoner, 2026; Mortgage Introducer, 2025). This illustrates an interaction between area religious composition and the child friendliness context.

Another contextual feature is the fertility gain in higher SES neighbourhoods related to housing equity gain, and to relative spatial movements in house prices, in turn determined by local housing markets. These features define the spatial environment for owner occupancy, one subject to policy intervention and important in defining household “opportunity sets” that inter alia affect fertility decisions (Rohe et al, 2002). This illustrates an interaction between area socio-economic composition and the housing environment context.

The other main environmental influence on fertility is the urban-rural contrast, which may reflect perceptions of urban areas as less child friendly (Jansson et al, 2022), access to green space and larger housing outside metro areas (Kurek, 2026), and for some urban areas, such as London, extremely high house prices and rents (Beck, 2026) and high child care costs. Urban level is discussed as a strong contextual influence on fertility in Chinese counties by Hu et al (2025a).

These authors also use county economic development as a proxy for costs of living. Our study has emphasized local house price differences as a major influence on housing costs, overall living costs and incomes after housing costs. Thus, Cribb et al (2023) report that “recent cohorts are facing far higher housing costs in early adulthood than previous cohorts did at the same age”. High house prices in some regions have meant younger cohorts are more dependent on private renting, a further deterrent to family

rearing (Houillon et al, 2026, section 2.4). London, the region where fertility has declined most (see Table 1), has seen the highest housing costs, and greatest growth in private renting.

Fertility decline in the most urban areas has been a major driver of the overall trend to reduced fertility in England. But the fall in fertility in London exceeds that in other metropolitan areas, for example in the North and West Midlands. This “London effect” is discussed in Beck (2026), who mentions especially deterrent effects of high house prices in relation to incomes, and high child care costs, which are also mentioned in South West Londoner (2026).

A caveat to the current work may be mentioned. In common with small area health indicator studies, is its ecological nature: inferences about the behaviour of individual families cannot be made directly.

Also worthy of mention is that available data on births in England’s small areas has further research potential. Birth totals back to 2013 can be obtained for smaller areas than MSOAs, namely Lower Super Output Areas averaging 1500–2000 population, and a trend analysis with several time points is possible.

Policy implications can be mentioned. The Centre for Progressive Policy (2024) report argued that much of the UK fertility decline can be linked to political funding and spending choices. In so far as contextual effects are amenable to policy intervention, then the present study has highlighted the major role of the housing market and house price environment as influencing fertility choices. As another type of intervention, deterrent effects of high child care costs in cities such as London – potentially important for lower income families - may be mitigated by free or subsidised child care for under 5s.

Declarations

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Data Availability. Data and code are at Harvard Dataverse. Private URL to Review: https://dataverse.harvard.edu/previewurl.xhtml?token=81d58046-50b7-4f42-bb35-134ab06ec444

Clinical trial number: not applicable

Ethics, Consent to Participate, and Consent to Publish declarations: : Not required as study uses anonymized aggregated area Census and Vital Statistics data (not individual data) which is publicly available at https://www.nomisweb.co.uk/.

Author Contribution

PC wrote and revised text, curated data and undertook data analysis

Data Availability

Data and code are at Harvard Dataverse. Private URL to Review:https://dataverse.harvard.edu/previewurl.xhtml?token=81d58046-50b7-4f42-bb35-134ab06ec444

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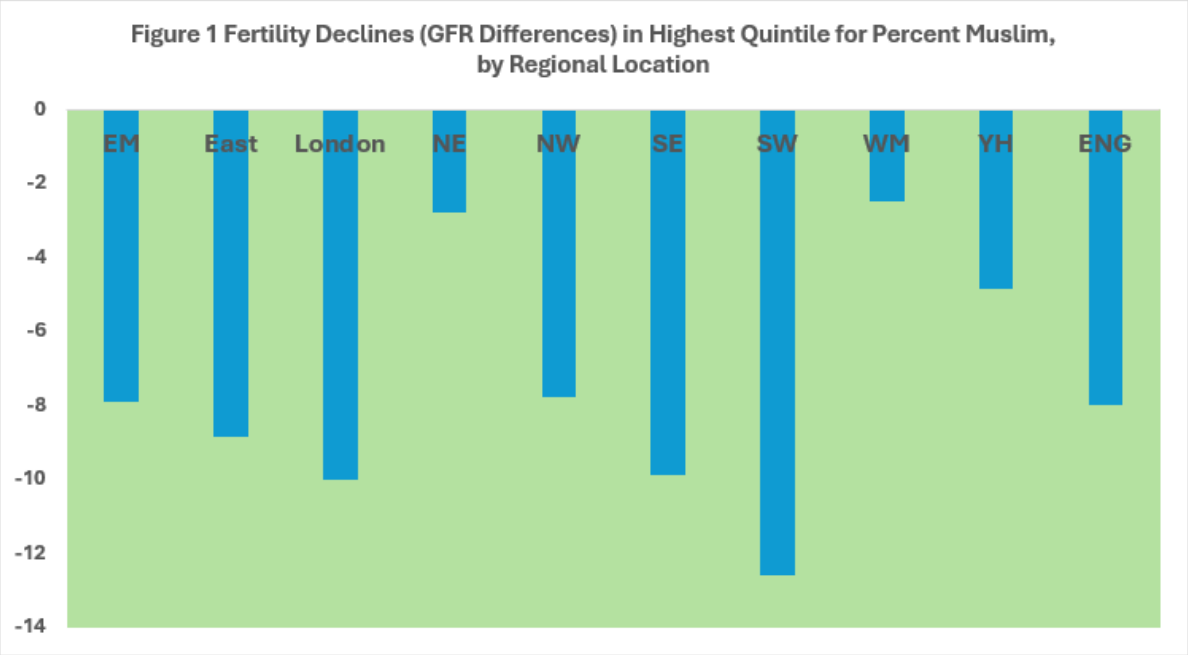
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Figures



Region	Abbrev	Region	Abbrev
East Midlands	EM	South East	SE
East of England	East	South West	SW
London	London	West Midlands	WM
North East	NE	Yorkshire and Humberside	YH
North West	NW	England	ENG

Figure 1

See image above for figure legend.

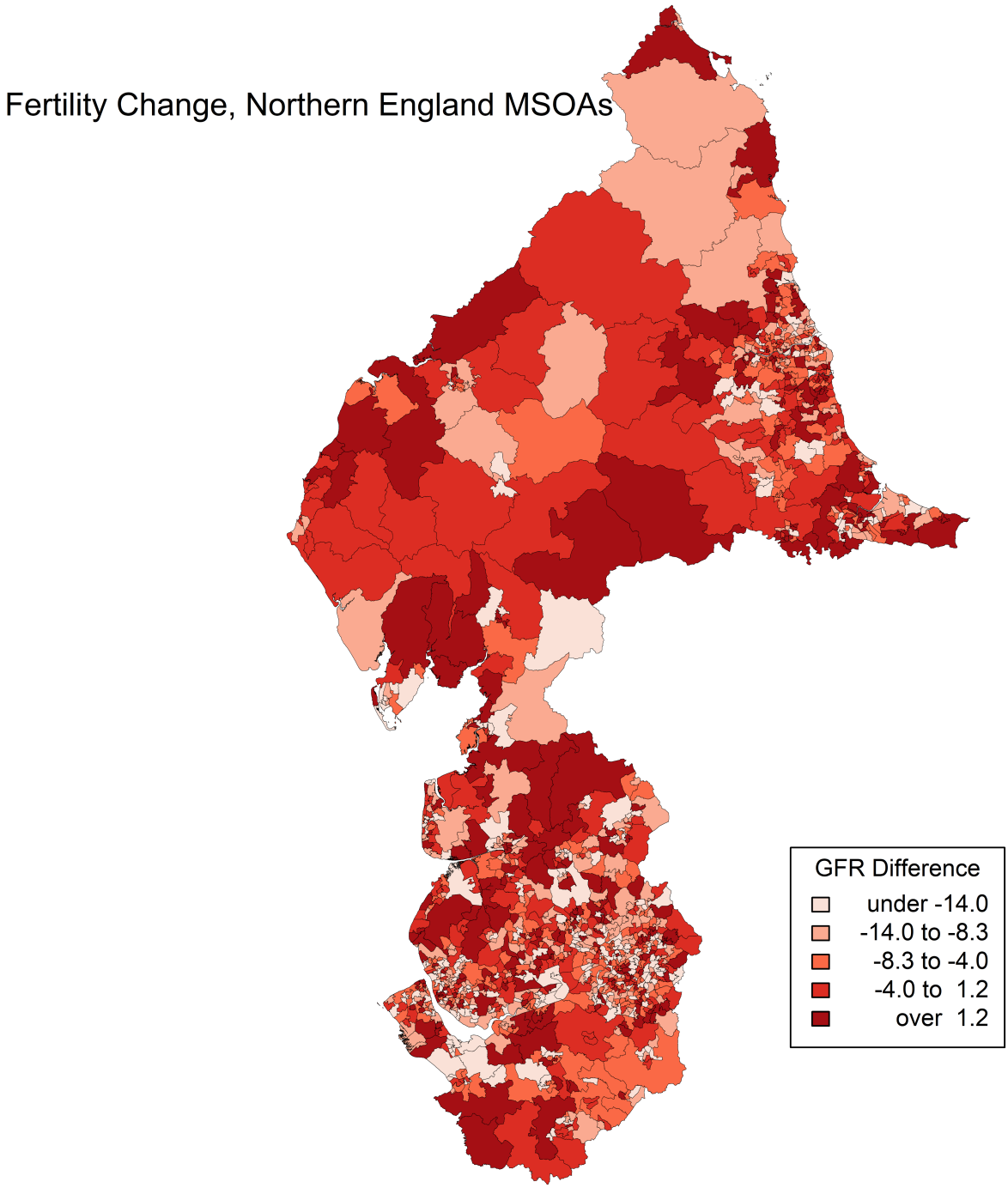


Figure 2

Fertility Change (GFR in 2024 minus GFR in 2019)

in Northern England MSOAs

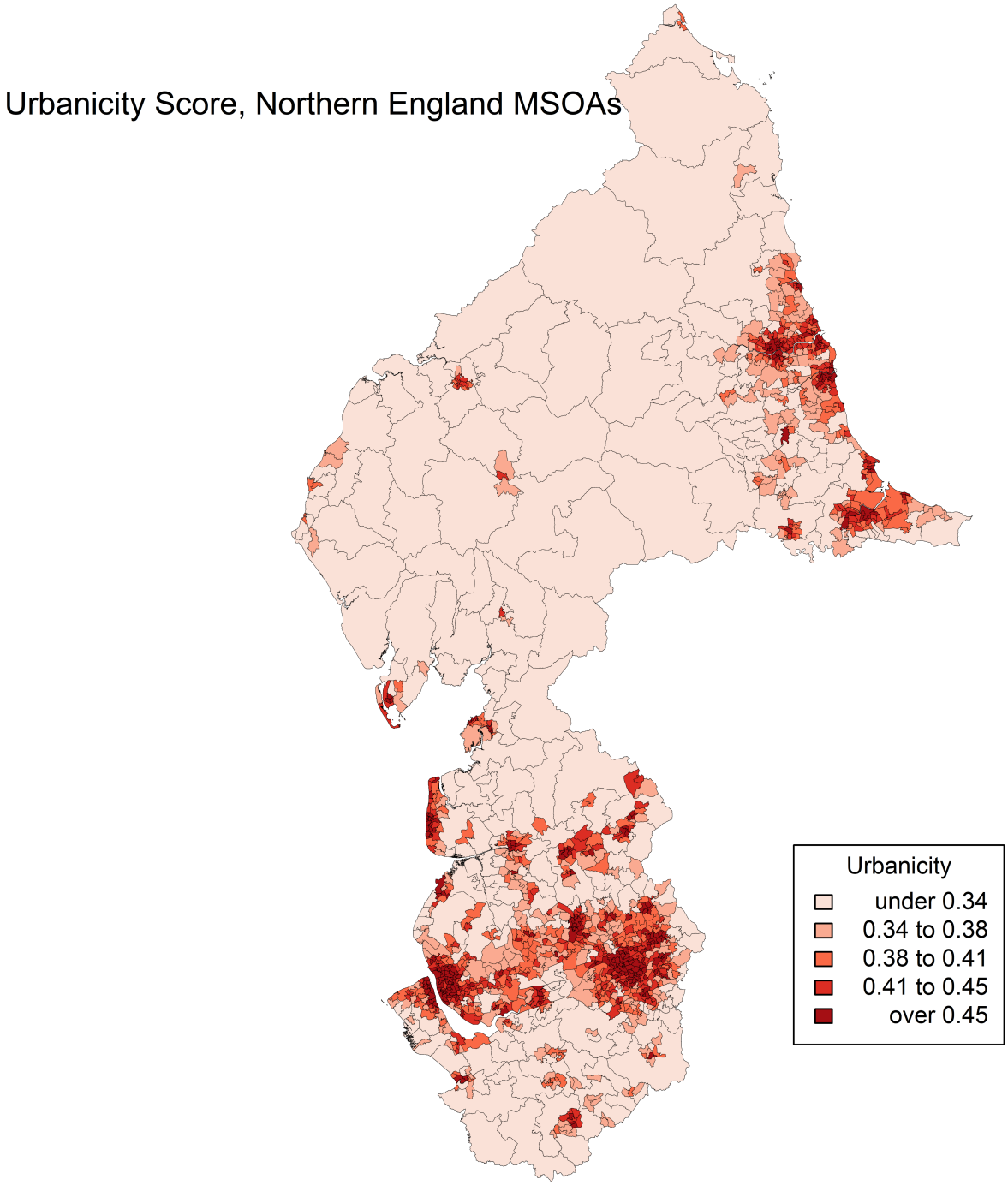


Figure 3

Urbanicity Scores, Northern England MSOAs