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Contextualising demography: the significance of local clusters of fertility in Scotland

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Contextualising Demography: The Significance of Local Clusters of Fertility in Scotland

Abstract

This study links empirical analysis of geographical variations in fertility to ideas of contextualising demography. We examine whether there are statistically significant clusters of fertility in Scotland between 1981 and 2001, controlling for more general factors expected to influence fertility. Our hypothesis, that fertility patterns at a local scale cannot be explained entirely by ecological socio-economic variables, is supported. In fact, there are 'unexplained' local clusters of high and low fertility, which would be masked in analyses at a different scale. We discuss the demographic significance of local fertility clusters as contexts for fertility behaviour, including the role of the housing market and social interaction processes, and the residential sorting of those displaying or anticipating different fertility behaviour. We conclude that greater understanding of local geographical contexts is needed if we are to develop mid-level demographic theories and shift the focus of fertility research from events to processes.

Keywords

Context, fertility, Scotland, local clusters, geography

1. Introduction

Within Europe, there has been considerable interest in the factors that might explain the enduring trend of low fertility which has accompanied the ‘second demographic transition’ (Lesthaeghe 1995). For example, we have learnt much about the role of demographic factors, such as the postponement of child-bearing (Kohler *et al.* 2002) and processes of family formation and dissolution (Billari and Kohler 2004), as well as socio-economic factors, such as women’s engagement in the labour market (Engelhardt *et al.* 2004) and educational attainment (Hoem *et al.* 2006a, 2006b).

The search for grand meta-narratives which explain the dynamic fertility patterns in Western Europe is ambitious and there is a growing recognition of the need to seek more contextualised theorisations. Lesthaeghe (1998) argued some time ago that demographers should be wary of de-contextualised grand theories, arguing that while the processes which shape demographic life events are undoubtedly related to individual characteristics, they are also likely to be influenced by national institutional structures and attitudes. Indeed, a number of important cross-national studies of fertility have provided useful insights into the various factors which help to explain contemporary fertility decision making. For example, Caldwell and Schindlmayr (2003), in their comprehensive examination of low fertility countries, argue that simple models based on welfare systems or family structures are too restrictive. They reflect on a range of possible influences including: the contraceptive and attitudinal revolutions of the 1960s; the economic crisis of the 1970s and the subsequent liberal economic revolution that attempted to answer that crisis; continuing integration into the European Union and subsequent widespread unemployment in Southern Europe; and the different family contexts which exist in Southern and Northern Europe. In combination, then, a variety of contextual factors are likely to have set the scene for persistent low fertility.

There has also been considerable debate about whether fertility patterns will converge over time. Wilson’s (2001) global examination suggests that demographic convergence is progressing far more rapidly than economic convergence. On the other hand, recent findings also indicate that national variations in fertility continue to persist in Europe (Coleman 2002, Frejka and Calot 2001). These may be related to national variations in other socio-demographic processes, such as the timing of leaving the parental home and of marriage, as well as female labour force participation, all of which are known to influence fertility behaviour (Billari and Kohler 2004). Cross-national studies have much to offer when we attempt to understand the influence of different national cultures, welfare policies or labour markets on fertility behaviour. However, there are good theoretical reasons for thinking that apparently similar levels of (low) fertility in different European countries could be caused by rather different contributory factors (Reher 1998) and that the processes implicated in fertility change operate at a variety of different geographical scales. Context matters in fertility research (Boyle 2004), especially if we take seriously the need for mid-level theories and a shift in focus from events to processes in the understanding of demographic behaviour (Hobcraft 2006).

Yet, in privileging the search for national-scale explanations, too little attention has been paid to the demographic significance of context at other geographical scales. Kulu *et al.* (2006) suggest that this is because of an assumption that childbearing patterns are relatively consistent across regions in 'post-transitional' societies and that, even where variations do exist, there is an expectation that relatively high fertility, more traditional areas will 'catch-up' with low fertility, more modern areas over time. The beguiling simplicity of demographic transition theories apparently retains the capacity to influence demographic thinking, despite trenchant criticism from many quarters (Szreter 1993, Greenhalgh 1996, Graham 2000, Riley and McCarthy 2003).

Understanding context not only disrupts the search for meta-theories but also demands an approach that gives due consideration to the *interplay* between social structures and social interaction processes/interpersonal relationships. The dynamic outcomes of this interplay are manifest at a variety of spatial scales for, as Hobcraft (2006: 172) puts it, structural elements "… can operate at quite different levels of aggregation". Thus the challenge for researchers becomes the identification of appropriate geographies through which the impact of social, political, economic or institutional structures might be revealed. This is less than straightforward since some social practices, relating to gender roles for example, may play out over large geographical areas but, at the same time, there may be important differences in their influence at much more local levels. Theoretical understanding of scale in fertility analysis requires greater attention if we are to avoid unfounded and potentially misleading *a priori* assumptions about demographically meaningful geographies.

Past studies that examined intra-national fertility variations provide a starting point for exploring demographic geographies and questions of spatial scale. Such studies have consistently demonstrated that fertility rates are lower in urban than in rural areas within both developed and developing countries, and this pattern appears to have endured through time (Courgeau 1989, Heaton *et al.* 1989, United Nations 1980). For example, the Princeton European Fertility Project confirmed this (Coale and Watkins 1986, Sharlin 1986), as did early research in Germany (Knodel 1974), Italy (Livi-Bacci 1977), Belgium (Lesthaeghe 1977), Canada (Trovato and Grindstaff 1980) and the US (Kiser *et al.* 1968). More contemporary studies confirming lower urban fertility rates have been conducted in countries such as France (Noin and Chauviré 1991), the US (Glusker *et al.* 2000), Italy (Michielin 2004), Estonia (Kulu 2005), West Germany (Hank 2001), the Netherlands (Mulder and Wagner 2001), Austria and Poland (Kulu 2006), Denmark, Finland, Norway and Sweden (Kulu *et al.* 2006), and Egypt (Weeks *et al.* 2004), although premarital birth rates (South 1999) and teenage pregnancy rates (Diamond *et al.* 1999, Harding 2003, Kirby *et al.* 2001) tend to be higher in poorer metropolitan areas. There is also some debate about whether these urban/rural variations are diminishing (Coleman 1996, Courgeau and Pumain 1993) or persisting (Hank 2001, Kulu 2005, 2006) over time. The consistency of the main findings, however, indicates that different geographical areas may well constitute significantly different demographic contexts in terms of the ways in which structural factors impact on fertility behaviour.

In the rest of the paper, we explore this possibility using contemporary data for Scotland. A notable characteristic of most studies of intra-national fertility variations is that they are based on crude geographical aggregations, distinguishing broadly between ‘urban’ and ‘rural’ areas. Aside from the definitional problems that beset such a division, it risks presenting a rather static and limited picture. Towns and cities shade into their rural hinterlands as sub- or peri-urban dwellers commute to the urban centre for work or recreation. Nor are large cities homogeneous, either across space or through time. And it is precisely the interplay between structural factors and social interaction processes that creates this dynamism. In the 21st century, high levels of population mobility and the attendant potential for more fluid demographic geographies necessitate a re-thinking of how spatial context and scale are to be understood in population research. If urban/rural classifications are too simplistic, and we think they are, how then are we to approach the empirical study of context?

One option is to start at a *local* scale. It is currently rare for studies to explore local variations in fertility across a large number of small areas within a single nation, controlling for demographic and socio-economic factors expected to influence fertility behaviour more generally, and rarer still for such analyses to explore change through time (although see Weeks *et al.* 2004). As Boyle (2004) points out, geographers have contributed relatively little to discussions of contemporary fertility in recent years, despite their evident interest in the complexities of space and scale. Moreover, available data too often impose limitations on the geographies that can be investigated in empirical models, with taxonomies treated as no more than a convenient way of identifying population groups (Graham 2000). Yet contextualising demography requires more than that and it is our contention that exploring local variations in fertility can inform the development of the mid-level theories, as advocated by Hobcraft (2006), by allowing us to tease out broader trends through time and across different spatial contexts.

Here we examine local-scale variations in fertility using information drawn from Scottish vital events records for three time periods spanning two decades, with the aim of exploring the geography of fertility. Our hypothesis is that local variations in fertility cannot be explained entirely by socio-economic characteristics. First, we model the likelihood of giving birth by women's age. Mother's age was recorded from the vital events information and is therefore an individual level variable. Second, we introduce a range of ecological variables drawn from the 1981, 1991 and 2001 censuses, in order to identify which factors are most associated with fertility patterns and how consistent these relationships are over time. Third, we investigate whether there are significant ‘local clusters’ of fertility. Rather than simply demonstrating where birth rates are high or low, in this part of the analysis we use sophisticated cluster analysis techniques to identify clusters of small areas where fertility is significantly higher or lower than expected, controlling for a range of explanatory factors. Fourth, we examine whether fertility clusters display continuities or change through time. This allows us to assess the extent to which fertility contexts are fluid, reflecting the spatio-temporal dynamics of structural influences. Finally, we discuss the implications of our findings for the understanding of context in demography, suggesting that local fertility variations may be associated with both context-specific and selection effects.

2. Fertility variations in Scotland

Scotland currently has the lowest fertility of the component countries of the United Kingdom (Boyle and Graham 2003a, Graham and Boyle 2003, 2004). After the baby boom period of the 1960s, the total fertility rate (TFR) fell quite steeply during the 1970s and 1980s, reaching an historic low of 1.48 in 2002. Although the most recent estimates suggest that Scotland’s TFR has risen slightly since, it remains the lowest in the UK since the rise has been paralleled in the other constituent countries. Scotland’s 5.1 million people (2005 estimate) are distributed unevenly over its relatively large landmass, with many being remote from its major urban centres in the central belt. There are also significant regional variations in fertility within Scotland. The general fertility rate (GFR) tends to be higher in the rural highland and island areas and lower in the cities. The council areas (of which there are 32 in Scotland) with the highest GFRs in 2002 included the Western Isles and Moray at over 54 per 1,000, while the GFR for the City of Edinburgh was 41.3 per 1,000, 14 percent below the Scottish average (General Register Office for Scotland 2003: 36). To date, there is almost a complete absence of research which explores the factors that are associated with these geographical variations. Nor are there good theoretical reasons for assuming that it is broad urban/rural differences that are demographically significant. Indeed, contextualising fertility is likely to require an understanding of more detailed geographies, including variations within council areas and within different cities.

In the presentation of our results below, we focus particularly on fertility patterns within and around the four largest cities (Aberdeen, Dundee, Edinburgh and Glasgow). Of these, Edinburgh is the national capital and home of the relatively new Scottish Parliament. Glasgow is the largest city in Scotland, containing some of the most deprived areas within the UK, but also some relatively wealthy neighbourhoods. Aberdeen is smaller than Edinburgh and Glasgow and has been influenced strongly by the oil industry which brought considerable wealth to the city during the 1980s and 1990s. In contrast, Dundee, the smallest of the four, has suffered considerably from de-industrialisation and has largely failed to experience the gentrification that Scotland's other three large cities have witnessed.

3. Data and methods

Data

The data for this study come from two sources. Information on each live birth in Scotland was extracted from the vital events data for three year periods – 1980-82, 1990-92 and 1999-2002 – which straddle the 1981, 1991 and 2001 Censuses. These data are collected by the General Register Office for Scotland (GROS) and, despite their high quality, have rarely been used in geographically detailed fertility analyses.

Each birth record includes the age of the mother and a geographical identifier, equivalent to the smallest areas for which data were released at the three most recent Censuses (Enumeration Districts (EDs) in 1981 and Output Areas (OAs) in 1991 and 2001). The boundaries of these zones have changed over time and their sizes vary, making any local-scale comparative analysis difficult. However, the recent development of approximately 10,000 'Consistent Areas Through Time' (CATTs), which are unique to Scotland, has made reliable inter-censal comparisons possible. Described in detail elsewhere (Exeter *et al.* 2005), CATTs are amalgamations of *whole* 1981 EDs and 1991 and 2001 OAs which allow reliable comparison of data from the three censuses, without the need for interpolation methods.

We extracted information on population age and sex structure for each CATT for each period from the relevant census and these data were used as denominators in the analysis. A number of ecological variables, which we expected to be related to fertility patterns, were also extracted for the CATTs from all three Censuses. We included variables relating to the socio-economic circumstances of the areas (such as over-crowding, levels of car ownership, housing tenure and the percentage of young children aged 1-4 years living in the area), and to the characteristics of resident women (such as the percentages of married women, working women and women with higher educational qualifications). However, some relevant variables were only available in the 2001 Census (either because they were not asked in the 1981 and/or 1991 Censuses, or because the information was not collected in a consistent way across all three censuses). In particular, the presence of students in an area could be expected to reduce the fertility rate, but this variable was only reliably collected in 2001 when students were recorded at their place of study (In previous censuses students were recorded at their home address). Also, a question on religion was included in Scotland's 2001 census for the first time.

Thus, we present comparable models for all three periods, but we also extend the analysis for 2001 alone to include a wider range of possible explanatory variables. In particular, we fit models that include and exclude students in order to examine whether the fertility patterns we observe in central city areas are influenced primarily by the existence of a large community of young, predominantly childless women.

Methods

We modelled the count of births in a particular CATT for a particular age group (15-19, 20-24, 25-29, 30-34, 35-39, 40+) using negative binomial models (the distribution of fertility events was over-dispersed compared to the Poisson distribution). A series of models was fitted. The first, 'base' model, includes the woman's age as a single explanatory variable. A comparison of the parameters across the three periods provides an insight into the changing frequency of births among women of different ages, illustrating the commonly observed tendency to begin childbearing at increasingly later ages. The second, 'comparable' model, includes a number of ecological variables which are common across the three censuses, allowing us to make direct comparisons for these three periods. In this case, we are interested in exploring the relative importance of different variables and how this changed through time. The final 'full' model was fitted for 2001 alone and includes a number of additional variables that could not be replicated from 1981 and 1991 Census data.

Our major interest is to test for clusters of high or low fertility in Scotland and to ascertain whether or not these have changed through time. We therefore use the G* statistic (Getis and Ord 1996, 1992, Ord and Getis 1995), which indicates the extent to which a location (i) is surrounded by a cluster of high or low values. Different versions of this statistic have been developed. One option is to compare the value in location (i) with values in all locations within a specified distance from (i). However, the use of a single distance cut-off would be inappropriate in the light of our earlier argument emphasising the need to avoid *apriori* assumptions about demographically meaningful geographies. Thus, we use instead an alternative version which compares the value in location (i) with values in neighbouring areas, as determined in a Geographical Information System (GIS). The null hypothesis is that there is no association between the value found at location (i) and its neighbours. Positive values of G* that exceed a z-score of 1.96 (the .05 level of statistical significance) indicate that high values of the variable of interest are spatially associated with this location; negative values of G* less than -1.96 indicate a cluster of low values. Thus, rather than identifying particularly high or low values of the variable of interest, this statistic identifies where relatively high or low values tend to *cluster* together. For our analysis, we tested whether high or low residuals resulting from the modelling exercise, rather than high or low numbers of births, were clustered. Thus, controlling for a wide range of factors expected to influence fertility more generally, we use the unexplained variance in the models to ascertain whether there are *local* geographies of childbirth that might prove to be demographically significant contexts for understanding the dynamics of fertility behaviour.

4. Results

Tables 1-3 provide three negative binomial models for 1981, 1991 and 2001 which include only the age of the mother as a six category explanatory variable (age 15-19 was the base category). For 1981, rates of childbirth peaked among those aged 25-29 and were lowest for those aged 40+. This pattern was consistent for 1991 and 2001. Note, however, that over the three study periods relative to those aged 15-19 the likelihood of giving birth for those aged 20-29 declined, while it increased for those aged 30 and above; the parameter for those aged 35-39 was significantly lower than that for 15-19 year olds in 1981 and 1991, but by 2001 it was significantly higher. Also, the size of the negative parameter for those aged 40+ reduced considerably between 1981 and 2001. These results match what we would expect, with the youngest and oldest women having lower birth rates than women aged 20-34, and there being an increasing trend over the two decades for women to delay births.

Tables 4-6 provide comparable models for all three periods. In all three models, some of the highest z-scores are those relating to the woman's age, which is measured at the individual level. Note that once the additional ecological variables are included, most of which are significant, the likelihood of giving birth by age changes slightly. In both 1981 and 1991 those aged 20-24 are most likely to give birth, rising to 25-29 for 2001.

The results for the ecological variables are reasonably consistent through time. Of these variables, the percentage of women who were married is most strongly and positively related to births in all three periods. Although fertility rates among unmarried women have risen substantially over the last few decades, it remains the case that married women are considerably more likely to give birth. The second most important variable in all three periods is the percentage of children aged 1-4 living in the area. These types of family neighbourhood where young children are common are also those where birth rates are higher. In all three periods births were negatively associated with the percentages of women working either full- or part-time (note, though, that the parameter for women working full-time becomes insignificant in 2001). This is interesting as it is the opposite of results reported in some national-scale studies, where the relationship between fertility and women's labour market employment has apparently changed from negative to positive between the mid 1980s and the mid 1990s (Ahn and Mira 2002, Engelhardt *et al*. 2004, Kögel 2004). At the local scale, and controlling for a range of other relevant variables, our analysis suggests that high rates of women's employment continue to be associated with lower fertility levels in Scotland. On the other hand, we also find that areas with high percentages of unemployed men also have higher fertility rates. One variable that is notable for its changing sign over the period is the percentage of households in social renting. A reasonably strong negative relationship in 1981 becomes insignificant in 1991 and significantly positive in 2001. The Right to Buy legislation in the UK saw a transfer of social housing into private ownership during this period and the residualisation of the remaining council-owned housing stock. The attendant changes in housing market structures and the residential mobility that this implies may have had a widespread influence on spatial patterns of fertility in Scotland.

The dynamic interplay between such institutional structures and interpersonal relationships is likely to influence fertility behaviour at a variety of spatial scales, however, and our major aim was to test for more local variations, controlling for the ecological variables described above. We therefore undertook a cluster analysis of the residuals from each of the comparable models (Tables 4-6) and Figure 1a-b maps the results for 2001. Figure 1a presents these results for all 10,058 CATTs in Scotland. Only a few areas stand out as having significantly high or low fertility clusters, although the majority of CATTs are too small in area to be detected on this map. Further, the most populous CATTS (in the city areas) tend to be the smallest and are especially difficult to identify. Figure 1b therefore provides a cartogram where the size of each CATT is proportional to its population (Dorling 1996). This clearly identifies significant clusters of low fertility in the central belt cities of Edinburgh and Glasgow and in the east coast cities of Dundee and Aberdeen, as well as scattered pockets of high fertility across Scotland.

The urban bias of low fertility clusters is notable at this cartographic scale but a more detailed examination reveals less homogeneous local patterns. Figure 2 focuses in on each of the four cities, using the actual CATT boundaries. Care must be taken in interpreting these maps since the largest CATTS tend to contain the smallest populations. Bearing this in mind, we see that for Aberdeen (Figure 2a) there is a clear cluster of low fertility in the city centre, surrounded by clusters of high fertility on the edge of the city and beyond. Broadly speaking this picture is matched in Dundee (Figure 2b), Edinburgh (Figure 2c) and Glasgow (Figure 2d), although in the latter there is an identifiable divide across the River Clyde, with a strong cluster of low fertility to the north and a number of clusters of high fertility to the south.

These spatial patterns of fertility have not remained constant through time. While national TFRs fell from 1.84 in 1981, through 1.69 in 1991, to 1.49 by 2001, the geographical variations in fertility also changed. Patterns in and around the two largest cities, Glasgow and Edinburgh illustrate this dynamism. For Glasgow (Figure 3a-c), a dispersed pattern of low fertility clusters is evident in 1981. Over the following 20 years this became more concentrated in inner city areas north of the River Clyde. At the same time, the clusters of high fertility around the outskirts of the city reduced considerably and, by 2001, tended to concentrate south of the river. A rather different pattern is revealed for Edinburgh (Figure 4a-c). In 1981, low fertility clusters were similarly dispersed but the only pockets of high fertility lay to east of the city. By 1991, however, the geographical variations in fertility around Scotland's capital produced a much more striking pattern, with a low fertility concentration in the central city encircled by an almost continuous band of high fertility clusters. The remnants of this pattern remained in 2001, but the central low fertility cluster had extended northwards to the coast and the significantly high fertility cluster to the west had disappeared. A full discussion of these geographical variations through time is beyond the scope of this paper. Nevertheless, we report these results here to emphasise two points: first, that temporal change in fertility is accompanied by geographical change; second, that the dynamics of fertility clustering are likely to be responding to local conditions, including local housing market structures.

The models presented above are comparable since the variables are consistent across the three censuses. However, the 2001 census included a number of questions that were not available in both the 1981 and 1991 censuses. Thus, Table 7 includes the 'full' model with additional variables relating to religious affiliation, ethnicity, limiting long-term illness and the presence of students. The religion question was asked for the first time in 2001, while the ethnicity and limiting long-term illness questions were asked in 1991, but not in 1981[1]. The exclusion of these additional variables from the earlier 'comparable' models raises the possibility that the fertility clusters identified above reflect deficiencies in the models rather than meaningful local demographic contexts. For example, one important general reason for the clusters of lower fertility in the four Scottish cities (Figure 2a-d) may be the presence of students, and this is not taken into account in the 'comparable' models. A relatively large number of women students of child-bearing age reside in central cities and few will have children during the period of their studies. Thus, we might expect fertility rates to be lower in these areas as a consequence of the general tendency of students to delay fertility rather than being a more local demographic response.

The results shown in Table 7 remain largely consistent with those in Table 6, although the negative effect of the percentage of women working full-time becomes significant, the effect of the percentage of households in social housing weakens considerably, and the percentage of lower social class households becomes insignificant. All the new variables added are significant. As expected, fertility is positively associated with the percentage of people from non-white ethnic groups and negatively associated with the percentage of people suffering from limiting long-term illness. Surprisingly perhaps, areas with higher percentages of Roman Catholics and Church of Scotland/other Christians, tend to have lower fertility. However, the strongest effect is for the percentage of students in an area, which is negatively related to fertility as we anticipated. The important question now is whether, with these additional variables controlled in the improved model, fertility clusters disappear.

Our hypothesis that local variations in fertility persist once other local factors are taken into account is supported in the majority of cases. Figure 5a-b and Figure 6a-d demonstrate that, controlling for the extra variables, we still find significant clusters of low fertility in the main city centres of Aberdeen, Edinburgh and Glasgow and clusters of high fertility in their suburbs and surrounds. Like Kulu *et al.* (2006),

[1] The ethnicity question asked in 1991 was significantly different to that asked in 2001 – Platt *et al.* 2005.

therefore, we find that the presence of students does not explain the clusters of considerably lower fertility within the larger cities. Only in Dundee, the smallest of the four cities, does the previously significant cluster of low fertility disappear, suggesting contrasting demographic contexts in Scotland's urban centres. As we noted above, unlike the other cities following de-industrialisation, Dundee has yet to experience significant gentrification. Thus the socio-structural influences on its neighbourhood demography can also be expected to differ from those of the other cities. Urban contexts, it would seem, are not homogeneous, and to treat the 'urban' as a demographically significant category is to underestimate the complexities of contextualising demography.

5. Discussion

To our knowledge, this is the first study that examines fertility in small areas for an entire country through time, and certainly the first one in Scotland. We utilised births recorded in vital events records aggregated into approximately 10,000 consistent areas within Scotland. We related these to census variables extracted from the 1981, 1991 and 2001 censuses, and considered temporal change in the factors significantly associated with variations in fertility. We then examined whether the residuals from these models were spatially clustered, allowing us to identify local peaks and troughs in the outcomes of fertility behaviour. Our results demonstrate that around the four main Scottish cities, at least, there are distinct patterns of significantly high and low fertility, with clusters of low fertility in the centres and clusters of high fertility in the suburbs and extra-urban surrounds. A simple urban/rural classification would mask these intra-urban variations, where fertility clusters persist even when we control for a wide range of local-area variables that are shown to be associated with the number of births in a given period.

The ecological and repeated cross-sectional nature of this study precludes a causal interpretation, but these results would be consistent with at least two broad hypotheses. The first relates to *context-specific effects* in the different local areas where individual and structural factors interact in specific ways to influence women's fertility behaviour. The second concerns *selection effects* where women with different fertility expectations move to areas that are more accommodating to their lifestyle choices. Of course, these effects are not mutually exclusive. It is entirely plausible that both occur simultaneously, with one reinforcing the other.

The range of possible context-specific effects is considerable, with the housing market being one obvious contender. Not only does the quality, size and cost of housing vary spatially creating a differentiated geography even within relatively small settlements, but housing markets also shape and constrain demographic choices. Family housing opportunities are seen as less common in city centres where living spaces tend to be smaller and not detached (Kulu 2003); and, as some city neighbourhoods have gentrified, the relative cost of housing in these locations has risen more steeply than elsewhere. In Scotland, and throughout the UK, rates of owner-occupation are comparatively high, and many young adults feel obliged to ‘get on the housing ladder’ as early as possible. The central city areas with identifiable low fertility clusters tend to have younger populations than other areas and a housing stock dominated by flatted tenements with communal gardens. In Edinburgh, for example, the gentrification of tenement flats over the past decade, combined with demand pressures, has led to dramatic increases in house prices, especially for first-time buyers. While it has been established that those living in areas with low house prices may find themselves ‘locked’ into the housing market if the market price fails to cover their mortgage (Chan 2001)[2], it also seems possible that some groups may be locked in by rapid house price inflation. In areas of Aberdeen, Edinburgh and Glasgow, the continuation of house price rises and the likely gains to be accrued by staying in an owner-occupied property may be discouraging residential mobility and delaying family formation. On the other hand, central Dundee with a similar housing stock has not experienced the same degree of gentrification and house price increase; and it is there that we found no evidence of low fertility clusters in 2001, once demographic and socio-economic factors had been accounted for. This lends support to the hypothesis of local contextual effects, although much remains to be done to tease out the different pathways through which these influence fertility behaviour.

If the housing market structures are implicated in demographic geographies, there is at least one other way that their influence might be felt. This relates to prevailing social norms regarding what constitutes suitable accommodation for a family. Where once the tenements of Scottish cities housed large families, their gentrified flats are now regarded as more suited to childless individuals and couples. Expectations and lifestyles have changed, and with them the socially constructed 'requirements' of family life. Szreter (1996: 546) recognised the importance of social norms in fertility change over a decade ago:

> It is because fertility change was mediated by shifting roles and norms that it principally occurred not to whole social classes or to individual occupations but to social groups and communities. This is because roles, norms and social identities are essential elements of the shared language of any mutually recognising, communicating human group. They are constructed by and embodied in the shared social practices and values of social groups or what might more accurately be termed '*communication communities*'.

Little has been done since to investigate the geographies of 'communication communities' despite the possibility that significant social networks are grounded in local areas. There are clearly many dimensions to social interaction processes but peers living close-by may provide role models and influence aspirations. In this limited sense, fertility behaviour may indeed be 'infectious'. Those researching fertility in developing areas have acknowledged the important role of social interaction effects (e.g. Behrman *et al.* 2002, Bongaarts and Watkins 1996, Montgomery and Casterline 1996), but few studies have given serious consideration to the role of *local* geographical contexts in fashioning fertility norms (Watkins 1990). Caldwell and Schindlmayr (2003: 257) partly recognise the significance of the local while framing their discussion in more general terms:

> Over-arching conditions common to all developed countries determine fertility decline, but local and sometimes transient idiosyncrasies shape the timing and tempo.

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[2] This may be relevant to some living in the poorer central city council areas who may have taken advantage of the 'right to buy' their socially rented property, although we would not expect this to be common, nor that these groups would display low fertility.

We suggest that spatial context, at least in the 21st century, must be acknowledged as much more than the site of leaders and laggards in a common narrative of demographic progress that this quotation implies.

Very little empirical attention has been given to this issue in Western Europe, despite early calls for more research (e.g. Hammel 1990). Recently, Lesthaeghe and Neels (2002) have examined the spatial continuity of fertility behaviour through time at a sub-national scale in France, Belgium and Switzerland, but their reliance on diffusion theory is questionable since it leads to a truncated view of the pathways that might connect social norms and fertility behaviour. And Kohler *et al.* (2002), in developing a framework for analysing differences in low fertility across European countries, identify social-interaction processes as a major element. They hypothesise that social feedback, affecting the timing of fertility, has rendered the population response to social and economic change larger than direct individual responses would have been. However, their discussion too is underpinned by a linear narrative, the 'postponement transition', where the behavioural change of the innovators "… has an indirect effect on the incentives and normative context of fertility decisions in the population in general" (Kohler *et al.* 2002: 658). Although they have little to say about spatial context and focus entirely on national populations, the idea that social feedback has a discernible effect on fertility behaviour raises interesting questions about the geographical scales at which these influences occur. We suggest that their general claims about social learning might apply to a more local geography than they consider:

> The optimal timing of fertility may be a complicated decision for women or couples, especially in the context of uncertain and changing socioeconomic environments. Social learning provides a way to simplify and augment decisionmaking in this context. Childbearing and career experiences of friends are therefore likely to influence women's and couples' decisions about the timing of fertility". (Kohler *et al.* 2002: 657)

Of course, social learning is rarely spatially constrained. The reach of friendship networks and media impact can extend from the local to the global (Boyle and Graham 2003b), and population responses are likely to be manifest at several different scales. Nevertheless, we maintain that 'local' behaviour in respect of fertility may be especially influential. If the majority of neighbours living in similar accommodation are childless, for example, the local demand for childcare facilities will be low and changing social norms regarding 'appropriate' family housing are likely to be reinforced. That an individual's fertility behaviour can be influenced by their peers has been recognised by other researchers (e.g. Watkins 1990, Skirbekk *et al.* 2004, Sieving *et al.* 2006,) but the complex issue of the spatial scale of such effects has almost entirely been overlooked.

A number of other demographic processes can be expected to influence fertility behaviour (White 1998), and these may operate in a similar way in a local context. Thus, Smock (2000) suggests that 'feedback loops' are important for understanding recent trends in family patterns because changes in different dimensions of family life may be mutually reinforcing. Or, as Bumpass (1990: 483) puts it:

> The institution of the family is not seen in a fixed form against which we can judge current behavior. Rather, it is the collective representation of our changing family experience, as that experience interacts with its environment.

Rates of cohabitation, divorce, women's labour force participation and age at first marriage all vary spatially, and these may influence local attitudes and norms. The fact that our results and a number of other statistically sophisticated studies (e.g. Hank 2001, Kulu *et al.* 2006) demonstrate that local fertility differentials persist even when socio-economic characteristics are controlled is consistent with the hypothesis that *context-specific effects* operate at a local scale.

In addition to purely contextual explanations, we must also acknowledge the potential importance of *selection effects*. Housing markets are known to influence both residential mobility and fertility. Studies in other European countries, for example, have reported that the timing of moves into owner occupation is strongly related to life events, including the birth of children (Chevan 1989, Deurloo *et al.* 1994, Mulder and Wagner 1998, 2001). Thus delays in the transition to owner-occupation can be linked to postponement of childbearing (Castiglioni and Dalla Zuanna 1994, Ineichen 1979, 1981, Krishnan and Krotki 1993, Pinnelli 1995, Murphy and Sullivan 1985), although Mulder and Wagner (2001) suggest that any such postponement is short-term in Germany and the Netherlands. We have already noted the relatively higher proportion of owner-occupation in Scotland, where local housing markets differ from those in many other European countries. The pathways that link housing market structures to local fertility clusters in Scottish cities can also be expected to differ in important respects, even if underlying processes display some communality.

Population sorting in response to socio-economic and ideational change is one such process leading to *selection effects* capable of producing local fertility clusters. For example, in-migrants to low fertility areas may be selective of those preferring childless lifestyles or smaller families, while out-migrants may include relatively high proportions of women with, or hoping to have, larger families. Numerous studies have suggested the importance of migration effects on fertility patterns (e.g. Goldberg 1959, Goldstein and Goldstein 1981, Ritchey 1972). The data we used in this study do not allow us to examine the migration behaviour of mothers in Scotland. However, we can speculate that the growing fertility disparity between inner and outer city areas is at least partly attributable to selective migration (Kulu 2005). Michielin (2004: 344) found some support for this in her study of Turin, although the results did not reach significance:

> Women appear to be heterogeneous with respect to their propensity to leave the city and to have an additional child. Controlling then for possible correlation across these components, we found a slightly negative (although not significant) correlation. This partially supports the idea that out-migration may be perceived as a possible solution to fertility plans which cannot be completely fulfilled in the city. This is in line with findings suggesting that people may adjust the timing of events in the family life course in accordance with the availability of appropriate housing.

Clusters of high birth rates were found in the suburban and extra-urban areas surrounding each of the large cities in Scotland. In contrast, all cities, except Dundee, had significant clusters of low fertility in the city centre. If families are becoming increasingly reluctant to have, and bring up, children in city centres, there are implications for local-area mobility rates, particularly in a climate where young single adults are increasingly attracted to live in urban centres (Ogden and Hall 2001, Hall and Ogden 2003). It is noteworthy that in our significant low-fertility clusters for 2001 43% of households were single-person, compared to 32% elsewhere in Scotland. Whether this local population sorting is the result of lifestyle choices or the constraints of the housing market, or both, is currently unclear. What is apparent is the potential for *selection effects* to reinforce *context-specific effects* through the social feedback mechanism outlined by Kohler *et al.* (2002) and Smock (2000).

6. Conclusion

In our discussion, we have sought to link the results of our empirical analysis of the spatial clustering of fertility in Scotland to a wider project of contextualising demography. We have shown that significant local fertility clusters remain once other, more general, factors known to be associated with fertility variations are taken into account. In particular, we find clusters of low fertility in the centres of three of the four large Scottish cities and a number of clusters of relatively high fertility in the urban suburbs and peripheries, which are unexplained by variations in the demographic and socio-economic characteristics of the area populations. We suggest two hypotheses that might contribute to the explanation of this geographical pattern. First, that there are *context-specific effects* related to the interplay of structural factors (such as the housing market) and social interaction processes. Second, that the geographical concentration of contrasting fertility behaviours arises from *selection effects* whereby those making different fertility choices move to areas where like-minded individuals reside. These explanations are not necessarily mutually exclusive, and we expect that each may play a part. Investigating their role and relative contributions to local-scale fertility variations is a key focus for further research.

Our empirical findings provide evidence that context is important in understanding fertility in low fertility populations and allow us to contribute to recent theoretical debates. Hobcraft (2006) proposes some core innovations for research into demographic behaviour. One of his aims is to shift the focus from ‘events’ to ‘dynamic processes’ and their interplay. Another is to increase the attention paid to processes involving interactions between individuals and various contexts, including social, political and institutional structures as well as ‘other persons’. His outline of the contextual elements in demography does not extend to a consideration of the role of spatial context and the ways in which these interactions are 'placed', but we contend that geography matters. Social feedback may operate at several different scales. The existence and persistence of central city clusters of low fertility suggests that the local scale is one of these.

There has been considerable discussion in the fertility transition literature about whether demographic processes are converging across countries. Rather less work has considered sub-national or regional convergence, although both Coleman (1996) in Europe and Courgeau and Pumain (1993) in France found decreasing fertility variations across settlements over time, suggesting that urban / rural variations may eventually erode. Watkins (1990) also argued that within country demographic variations in fertility were lower in 1960 than they had been in 1870, suggesting the importance of the 'national community' in such decision making. On the other hand, more recent studies which control for socio-economic characteristics suggest that significant variations between settlements persist in Germany (Hank 2001), Estonia, Austria and Poland (Kulu 2005, 2006), and a number of Eastern European countries (Kučera *et al.* 2000). And, while Kulu *et al.* (2006) suggest that fertility variations across settlements have decreased over the last 30 years in Scandinavia, significant variations remain and the postponement of childbirth has become much more pronounced in the cities over this period.

Previous efforts to distinguish between urban and rural fertility behaviour fail to recognise the importance of smaller scale differentials. Our results, based on analysis of small areas within Scotland that are consistent through time, demonstrate a patterning of fertility behaviour in and around larger cities characterised by clusters of low fertility in the urban centre and clusters of higher fertility in the urban periphery. This geographical polarisation of observed fertility is likely to be linked in part to falling national fertility rates, as different individuals make different demographic and life-style choices. For example, the 'delay' in first birth that has accompanied recent fertility decline has also increased the scope for leading a child-free life-style and for fulfilling a particular set of residential preferences which place a high value on accessibility to city centre facilities. At the same time, social feedback may be reinforcing such choices and rendering the population response larger than direct individual responses would otherwise have been. Thus, by identifying significant local-scale geographical variations in fertility we can begin to understand the complex interplay between evolving structural elements such as the housing market and those social interaction processes that help to shape fertility behaviour.

We have argued that recognising meaningful demographic geographies is an important component of the project of contextualising demography, allowing us to refocus explanations of low fertility on the processes involved at different scales. Understanding the complex spatio-temporal dynamics of fertility change is a major challenge for future research in Demography. In 2001, around 54,000 women aged 15-44 in Scotland resided in areas with significant clusters of low-fertility. This represents about 5% of all women of child-bearing age. The extent of these clusters is likely to be influenced by selection effects reflecting life-style choices. However, if, as we speculate, the women resident in low fertility areas are delaying giving birth or reducing their completed family size at least partly in response to context-specific effects, the impact on Scotland's future birth rate could be considerable.

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TABLES

Table 1 1981 Base model

Number of observations = 60348
Log likelihood = -99530.426

	Coefficient	Standard Error	z	P>z
Age 20-24	1.2850	.0112	114.26	0.000
Age 25-29	1.4565	.0112	129.58	0.000
Age 30-34	.7732	.0119	64.78	0.000
Age 35-39	-.3519	.0149	-23.49	0.000
Age 40+	-2.0389	.0265	-76.71	0.000
Constant	-2.4649	.0091	-269.57	0.000

Table 2 1991 Base model

Number of observations = 60348
Log likelihood = -101351.02

	Coefficient	Standard Error	z	P>z
Age 20-24	.8989	.0123	72.85	0.000
Age 25-29	1.2531	.0119	104.46	0.000
Age 30-34	.8486	.0124	68.41	0.000
Age 35-39	-.2256	.0146	-15.44	0.000
Age 44+	-2.1650	.0254	-85.00	0.000
Constant	-2.3780	.0099	-238.05	0.000

Table 3 2001 Base model

Number of observations = 60348
Log likelihood = -98568.025

	Coefficient	Standard Error	z	P>z
Age 20-24	.7231	.0141	51.18	0.000
Age 25-29	1.0847	.0135	80.13	0.000
Age 30-34	.9589	.0134	71.53	0.000
Age 35-39	.1143	.0145	7.87	0.000
Age 40+	-1.6227	.0216	-74.86	0.000
Constant	-2.4313	.0109	-221.78	0.000

Table 4 1981 Comparable model

Number of observations = 60330
Log likelihood = -94536.242

	Coefficient	Standard Error	z	P>z
% of women who are married	.0140	.0002	70.27	0.000
% of women working full time	-.0056	.0003	-15.21	0.000
% of women working part time	-.0082	.0006	-13.33	0.000
% of women with higher qualifications	.0004	.0002	1.93	0.053
% of households in social renting	-.0016	.0001	-13.41	0.000
% of children aged 1 to 4	.0301	.0014	21.34	0.000
% of economically active men who are unemployed	.0064	.0006	10.26	0.000
% of households with no car	.0034	.0003	10.82	0.000
% of households that are over crowded	.0006	.0003	1.85	0.065
% of households with a lower social class head	.0004	.0002	1.72	0.085
Average number of rooms per household	.0188	.0075	2.49	0.013
Age 20-24	.6789	.0130	51.95	0.000
Age 25-29	.4524	.0171	26.38	0.000
Age 30-34	-.3394	.0188	-18.01	0.000
Age 35-39	-1.4817	.0210	-70.23	0.000
Age 40+	-3.160	.0304	-103.98	0.000
Constant	-2.6016	.0481	-54.06	0.000

Table 5 1991 Comparable model

Number of observations = 60048
Log likelihood = -97772.054

	Coefficient	Standard Error	z	P>z
% of women who are married	.0126	.0002	60.46	0.000
% of women working full time	-.0058	.0004	-13.69	0.000
% of women working part time	-.0060	.0005	-10.64	0.000
% of women with higher qualifications	.0003	.0002	1.57	0.117
% of households in social renting	-.0002	.0002	-1.06	0.287
% of children aged 1 to 4	.0392	.0015	24.88	0.000
% of economically active men who are unemployed	.0028	.0006	4.72	0.000
% of households with no car	.0027	.0004	6.80	0.000
% of households that are over crowded	-.0034	.0006	-5.05	0.000
% of households with a lower social class head	.0004	.0002	2.15	0.031
Average number of rooms per household	.0067	.0075	0.90	0.370
Age 20-24	.5951	.0125	47.34	0.000
Age 25-29	.5382	.0164	32.65	0.000
Age 30-34	-.0168	.0187	-0.90	0.368
Age 35-39	-1.1531	.0209	-54.94	0.000
Age 40+	-3.1198	.0297	-104.85	0.000
Constant	-2.4403	.0610	-39.94	0.000

Table 6 2001 Comparable model

Number of observations = 60342
Log likelihood = -95252.652

	Coefficient	Standard Error	z	P>z
% of women who are married	.0140	.0002	59.26	0.000
% of women working full time	-.0003	.0005	-0.64	0.519
% of women working part time	-.0029	.0006	-4.43	0.000
% of women with higher qualifications	.0027	.0004	6.11	0.000
% of households in social renting	.0036	.0003	10.33	0.000
% of children aged 1 to 4	.0768	.0021	36.33	0.000
% of economically active men who are unemployed	.0065	.0007	8.51	0.000
% of households with no car	.0028	.0005	5.79	0.000
% of households that are over crowded	-.0037	.0020	-1.80	0.072
% of households with a lower social class head	.0052	.0009	5.58	0.000
Average number of rooms per household	.0616	.0088	6.97	0.000
Age 20-24	.6047	.0133	45.24	0.000
Age 25-29	.6708	.0146	45.88	0.000
Age 30-34	.3004	.0171	17.53	0.000
Age 35-39	-.6529	.0192	-33.85	0.000
Age 40+	-2.447	.0255	-95.92	0.000
Constant	-3.430	.0776	-44.19	0.000

Table 7 2001 Full model including the student variable

Number of observations = 60342
Log likelihood = -94907.477

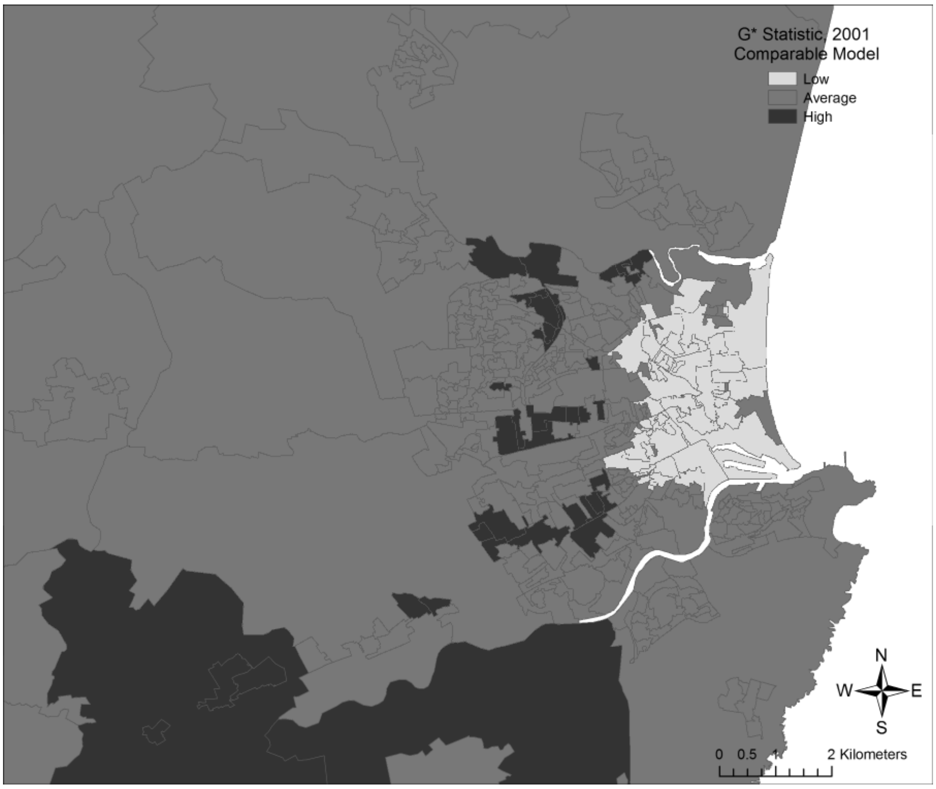
	Coefficient	Standard Error	z	P>z
% of women who are married	.0137	.0002	58.31	0.000
% of women working full time	-.0078	.0006	-11.81	0.000
% of women working part time	-.0057	.0007	-8.27	0.000
% of women with higher qualifications	.0035	.0004	7.77	0.000
% of households in social renting	.0019	.0003	5.61	0.000
% of children aged 1 to 4	.0575	.0023	25.13	0.000
% of economically active men who are unemployed	.0029	.0007	3.83	0.000
% of households with no car	.0030	.0005	6.07	0.000
% of households that are over crowded	-.0040	.0022	-1.81	0.071
% of households with a lower social class head	-.0002	.0009	-0.23	0.822
Average number of rooms per household	.0313	.0088	3.54	0.000
Age 20-24	.6041	.0131	45.96	0.000
Age 25-29	.6739	.0143	46.81	0.000
Age 30-34	.3091	.0168	18.30	0.000
Age 35-39	-.6428	.0190	-33.78	0.000
Age 40+	-2.4350	.0252	-96.33	0.000
% of population who are non white	.0054	.0026	2.09	0.037
% of women with limiting long-term illness	-.0020	.0009	-2.23	0.026
% of people who are Catholic	-.0013	.0004	-3.34	0.001
% of people who are Church of Scotland / other Christians	-.0033	.0005	-6.51	0.000
% of people who are members of other religions	-.0070	.0027	-2.55	0.011
% of people aged over 16 who are full time students	-.0177	.0006	-25.70	0.000
Constant	-2.3040	.0985	-23.39	0.000

Figure 1 Significant clusters of high and low fertility: national results from the 2001 comparable model

a) Standard CATTs **b) Cartogram CATTs**

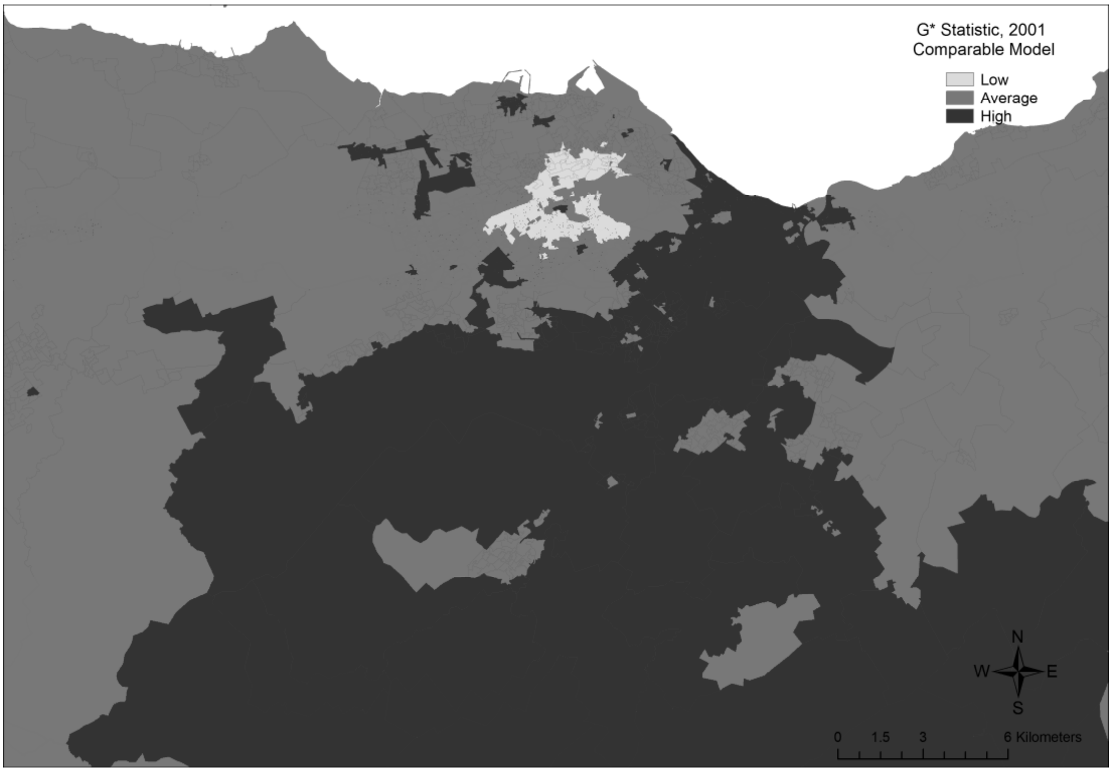
Figure 2 Significant clusters of high and low fertility: city results from the 2001 comparable model

a) Aberdeen



b) Dundee

c) Edinburgh



d) Glasgow

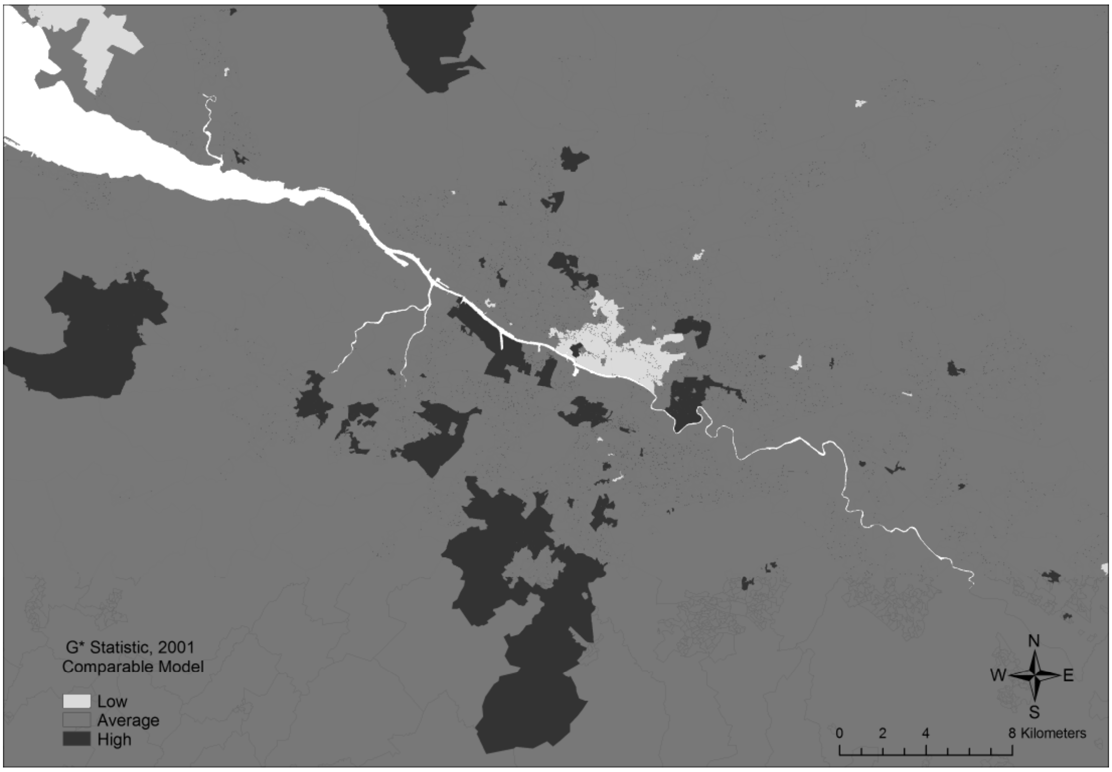
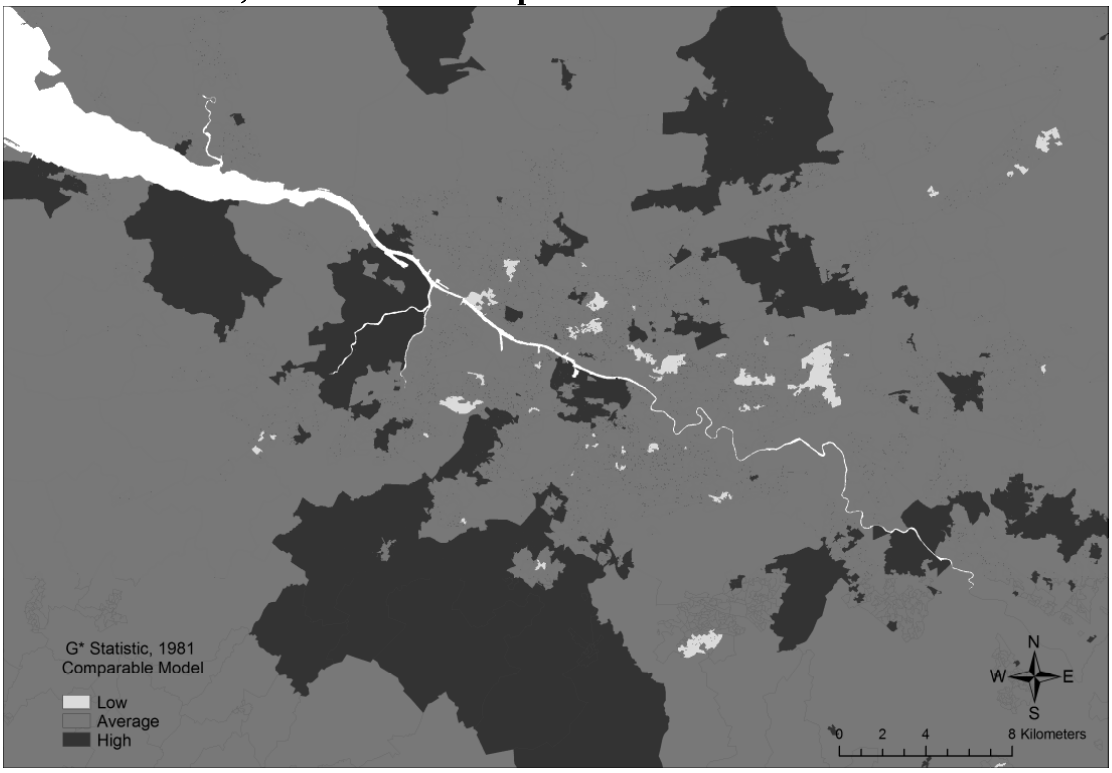
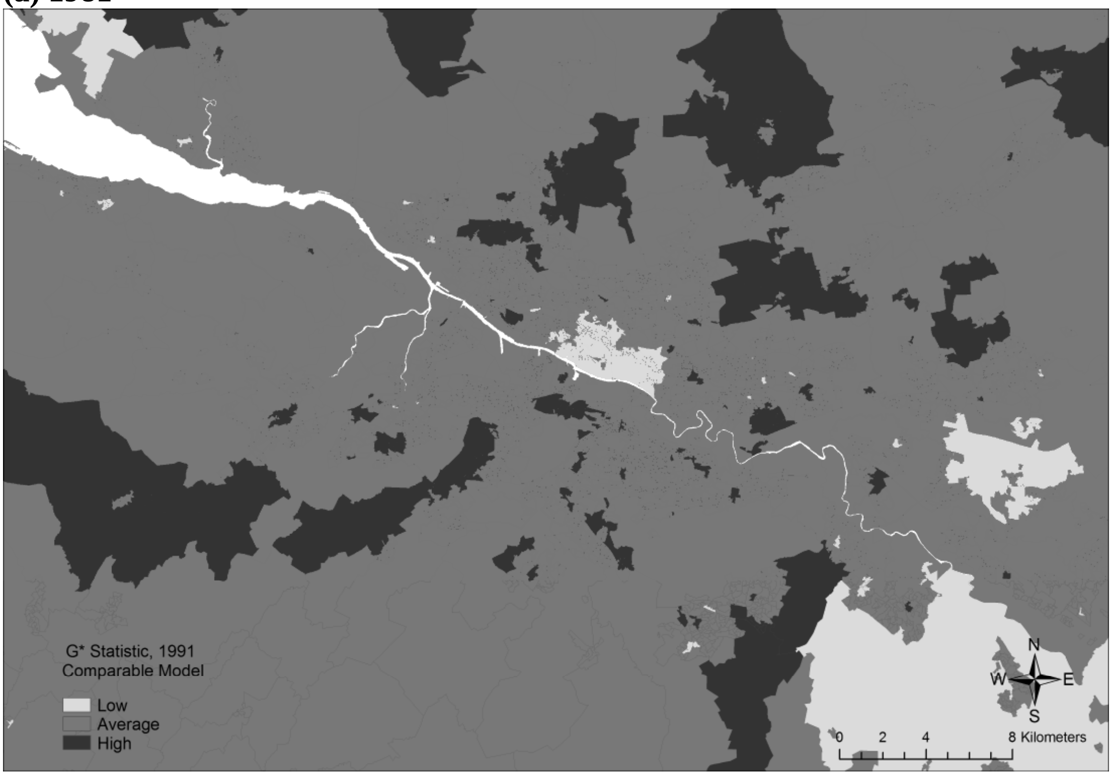


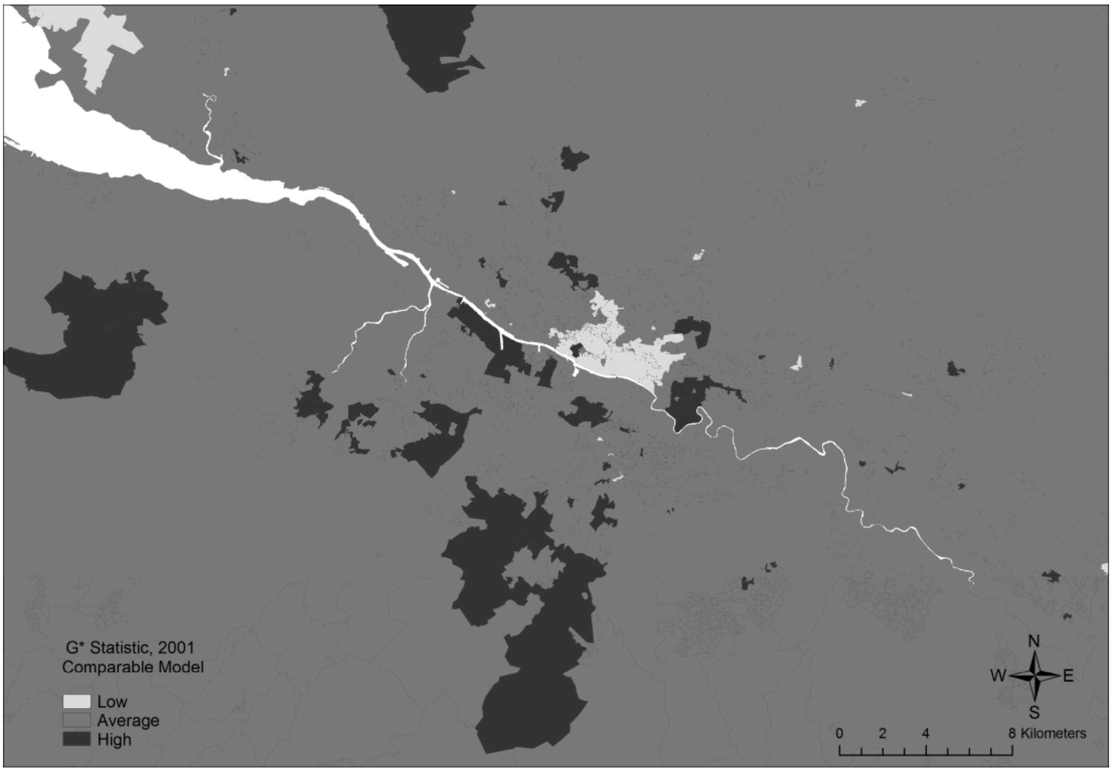
Figure 3 Significant clusters of high and low fertility through time: Glasgow results from 1981, 1991 and 2001 comparable models



(a) 1981

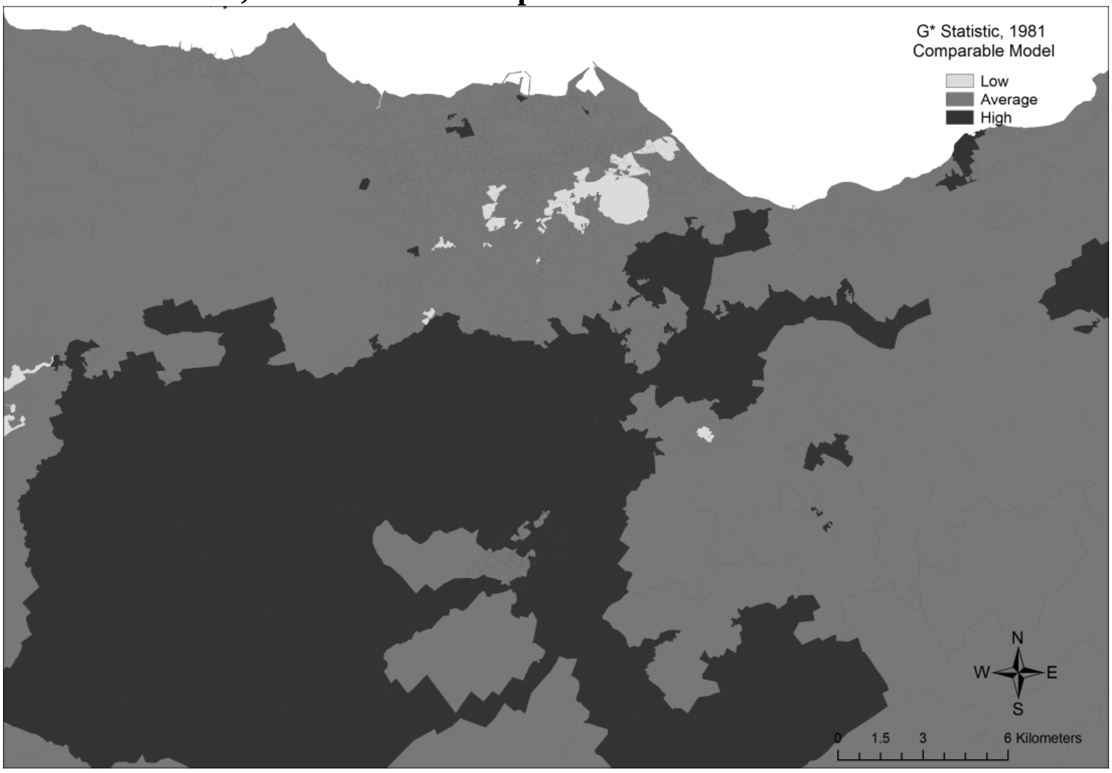


(b) 1991

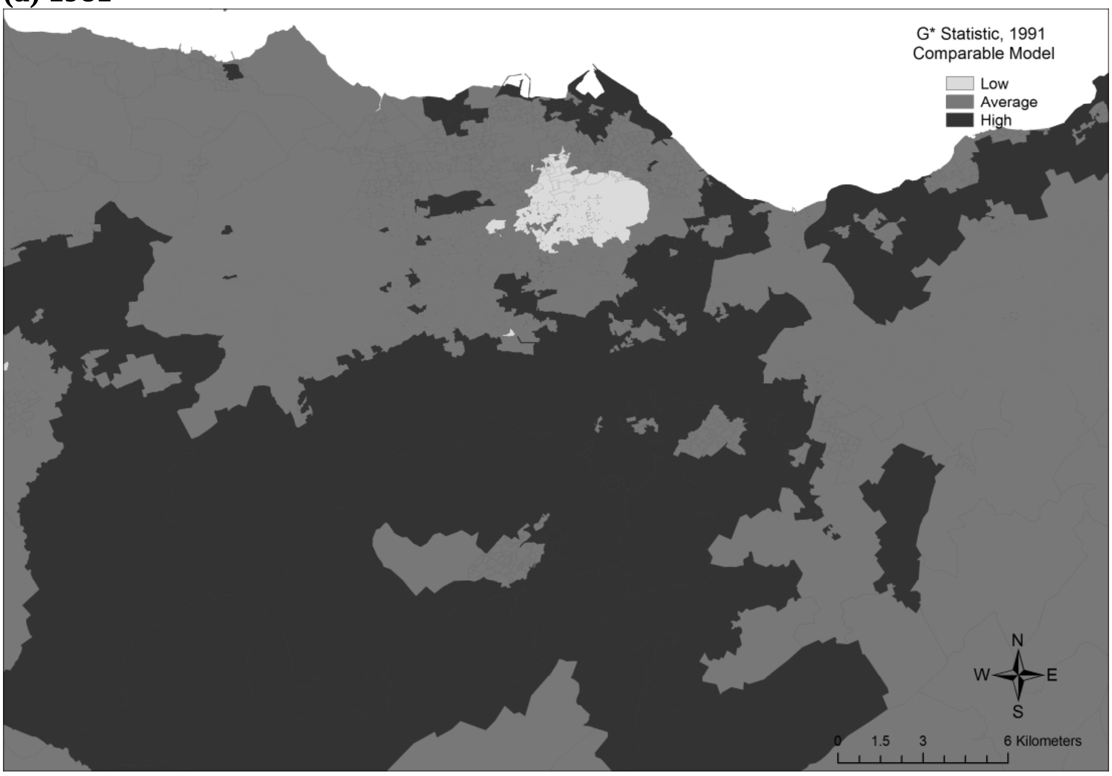

G* Statistic, 2001
Comparable Model
Low
Average
High
0 2 4 8 Kilometers
N
W
E
S

(c) 2001

Figure 4 Significant clusters of high and low fertility through time: Edinburgh results from 1981, 1991 and 2001 comparable models



(a) 1981



(b) 1991

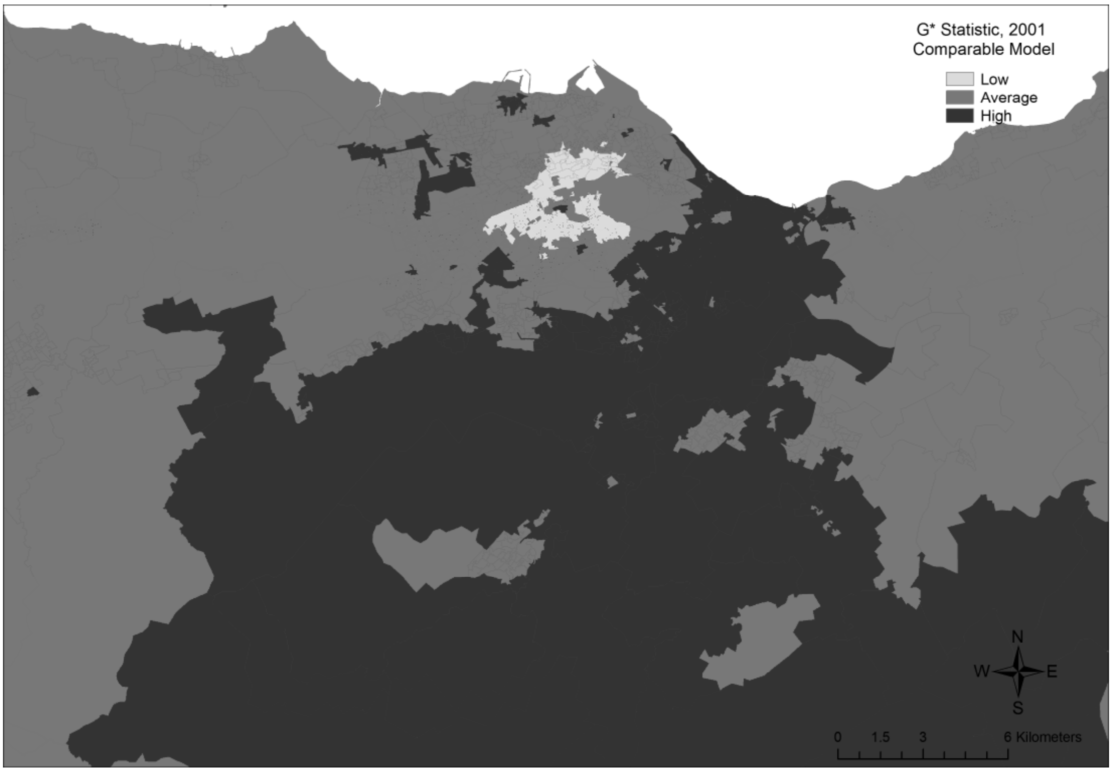

G* Statistic, 2001
Comparable Model
Low
Average
High
N
W
E
S
0 1.5 3 6 Kilometers
(c) 2001

Figure 5 Significant clusters of high and low fertility: national results from the 2001 full model

a) Standard CATTs **b) Cartogram CATTs**

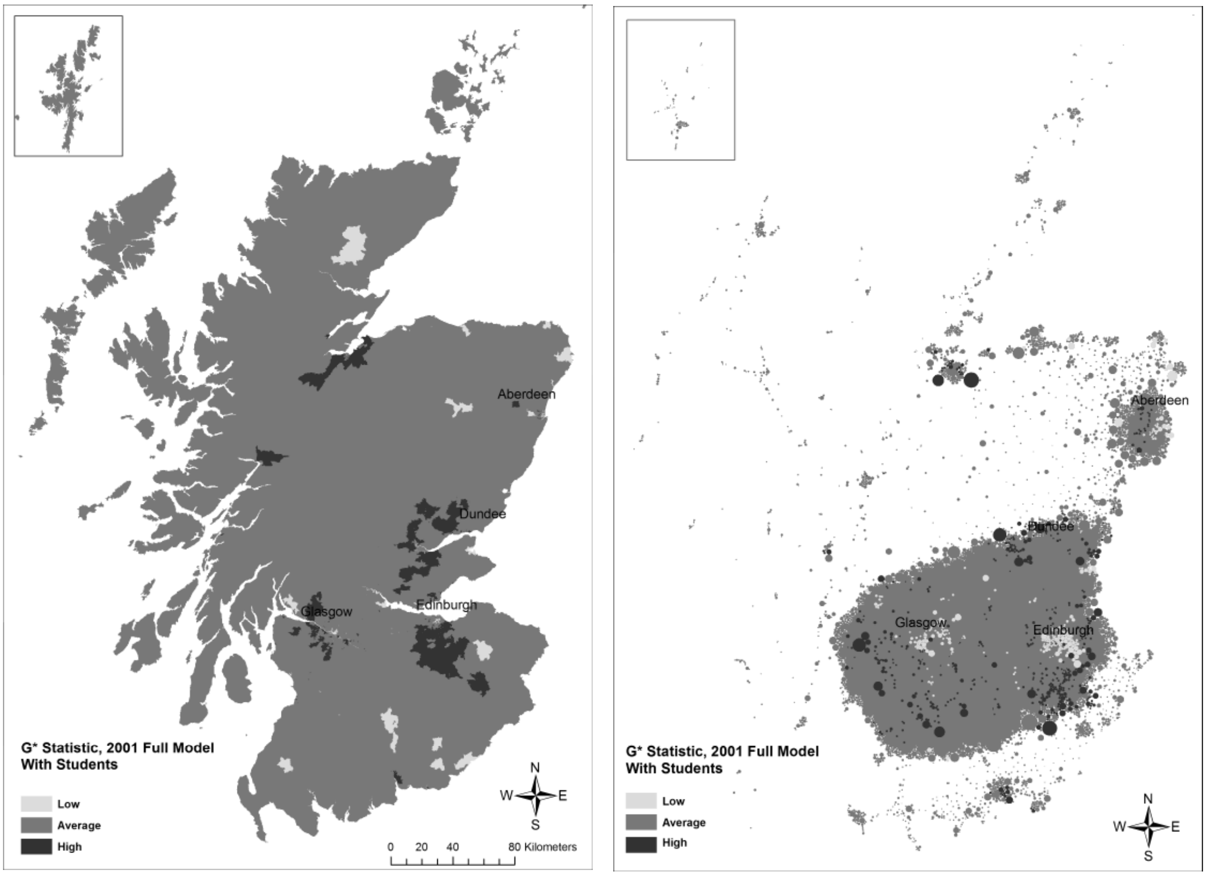
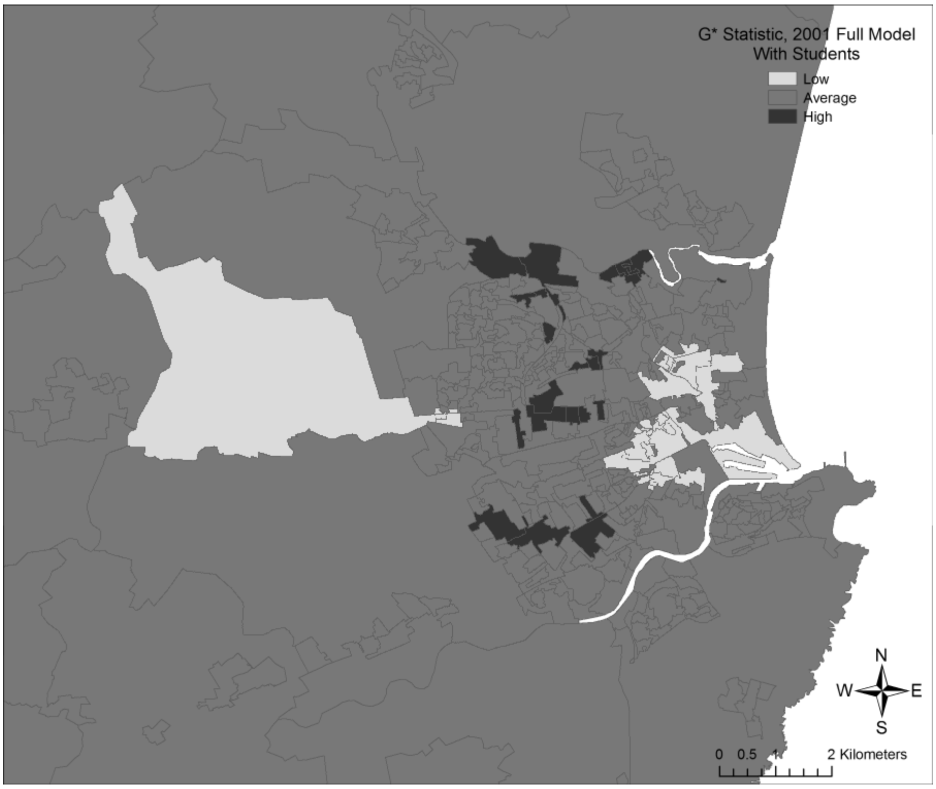


Figure 6 Significant clusters of high and low fertility: city results from the 2001 full model

a) Aberdeen



b) Dundee

c) Edinburgh

d) Glasgow