

ATTITUDES TO ETHNIC MINORITIES, ETHNIC CONTEXT AND LOCATION DECISIONS*

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Attitudes of ethnic majority populations towards other communities is a potentially important determinant of social exclusion and welfare of ethnic minorities. The suggestion that negative attitudes towards minorities may be affected by the ethnic composition of the locality in which individuals live has often been made and empirically investigated. We point to a potential for bias in simple estimates of ethnic context effects if individual location decisions are driven partly by attitudinal factors. We also suggest an instrumental variables procedure for overcoming such bias in data with appropriate spatial information. Our results suggest that such a correction may be important.

The attitudes of ethnic majority populations towards other communities is a potentially important determinant of social exclusion and of the welfare of ethnic minorities both indirectly through its impact on the political process but also more directly through experiences of personal hostility (see for instance the personal testimonies of immigrants to the United Kingdom recorded in Phillips and Phillips (1998)). Attitudes of majority populations also affect the process of social and economic integration of immigrant minorities.

Settlement of minority groups who enter European countries on a refugee basis has become a political issue of considerable importance. Local interest groups often oppose new settlements. Germany, for instance, had experienced in a very short time span a large inflow of ethnic Germans from former Eastern countries, and an inflow of refugees from the former Yugoslavia. The results of Krueger and Pischke (1997) suggest that high concentrations of minorities may have led to outbreaks of hostility against minorities, often ending in physical violence, and leading to death or severe injuries. Attitudes of intolerance may also manifest themselves in less dramatic but nonetheless socially corrosive behaviour. As Smith (1989, p.150) notes, such 'low-level' attitudes 'provide a reservoir of procedural norms that not only tacitly inform routine activity, but are also available to legitimize more purposive, explicitly racist, practice.' The data in the current paper deal with much less extreme sorts of reaction but these are reactions which may be driven by common sentiments and similar methodological issues clearly arise.

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The suggestion that negative attitudes towards minorities may be affected by the ethnic composition of the locality in which individuals live has often been made and empirically investigated. Contextual effects may arise if local ethnic composition has an impact on perceived threats to indigenous culture or identity (the group conflict theory; see, eg., Sherif and Sherif (1953)). Context also affects frequency of social contact which may undermine the grounds for hostility to those of different backgrounds (the contact hypothesis; see eg. Rothbart and John (1993) for details). Overall there is no obvious presumption that the sum of such effects should go in one way or the other.

Evidence on racial prejudice in the United Kingdom is discussed, for example, by Smith (1989). Schaefer (1975) found an 'association between the relative presence of non-whites and levels of prejudice' using data on five English towns. Studlar (1977), on the other hand, found 'the influence of social context variables on attitudes towards immigrants' to be 'almost non-existent'. Elkin and Panning (1975) investigate association between contact and prejudice, concluding that 'contact with the external referent of an opinion decreases the influence of neighborhood climate on that opinion'. All these studies use British data for the 1960s and early 1970s. A related and more recent literature is that which analyses electoral support for extreme right parties in the 1970s. Taylor (1979) and Husbands (1979) both look at spatial patterns in support for the National Front, finding some support for the hypothesis that such voting is a response to the threat of territorial encroachment by minorities.

A list of recent empirical studies of race-related attitudes in other countries that have included terms reflecting local ethnic composition would include Binder *et al.* (1997), Black and Black (1973), Cummings and Lambert (1997), Fossett and Kiecolt (1989), Frensdreis and Tatalovich (1997), Gang and Rivera-Batiz (1994), Gran and Kein (1997), Hood and Morris (1997), Stein *et al.* (1997) and Tolbert and Hero (1996). The vast empirical literature has not provided a definite answer as to which effect prevails. As noted by Rothbart and John (1993), 'there are roughly equal numbers of studies showing favourable, unfavourable and no effects of intergroup contacts'. One should not necessarily expect consistency across studies using responses to different questions and data from different countries. However, even when looking at similar attitudes in the same country, findings may differ markedly. To take only the example of attitudes to Hispanic immigration in the United States, we find one recent study claiming that 'Clearly, Anglos living in areas with large Asian and Hispanic populations favor less restrictive immigration policies than do Anglos residing in more racially isolated communities'¹ whereas another claims that 'White attitudes towards Hispanics and Asians and policies favourable to immigration are negatively influenced by the concentration of minorities proximate to whites.'²

¹ Hood and Morris (1997) analysing data from the 1992 American National Election Study.

² Stein *et al.* (1997), using a 1996 telephone survey data set for Texas.

One contribution of this paper is a more up-to-date empirical analysis of the relationship in England between socio-economic variables and labour market indicators on the one hand, and the attitude towards a number of issues relating to ethnic minorities on the other hand. Our data are drawn from several years of the British Social Attitudes survey (BSA). Our dependent variables include a range of indicators of hostility towards minorities, which include self reported prejudice and attitudes towards inter-ethnic marriage, ethnic minority superiors at work and race discrimination legislation.

The second contribution is methodological. While the previous literature has sometimes recognised that attitudes may determine as well as be influenced by ethnic context, we are aware of no discussion of how one might attempt to identify the latter effect in the presence of the former. Racially intolerant individuals from the majority community are unlikely to choose to live in areas with large ethnic minority populations. Equally, ethnic minority individuals are unlikely to choose to live in areas where they expect to experience racial intolerance.³ Either of these phenomena would weaken any correlation between ethnic composition and attitudes and create a downward bias in straightforward regression estimates of the impact of ethnic context.

All the above mentioned papers estimate single equation models, where racial or ethnic composition is treated as an exogenous regressor. In some cases, this can be justified by the large size of the spatial areas across which ethnic context is measured but this is far from being generally true. We investigate the effects of minority concentration on these attitudes, taking explicit account of the simultaneity bias which arises. We argue that mobility is likely to be geographically limited by employment and family history. Ethnic compositions of larger areas may be regarded as beyond the control of individuals while showing high correlation with composition of smaller areas and are therefore likely to be good instruments for local ethnic context. Estimates of racial effects may be expected to be more robust the larger the spatial area within which ethnic composition is evaluated for the purpose of instrumentation.

This problem is econometrically similar to that of so-called Tiebout bias in studies of preferences for local public goods (see, for instance, Rubinfeld *et al.* (1987), Olmsted (1985)). Identification of the effect of local public spending levels on willingness to pay for spending increases are bedeviled by the likely tendency of individuals to migrate to areas spending close to their preferred level, creating a sorting bias in crude estimates in exactly the same way that attitudinally motivated migration can upset estimation in the case being considered here. Sorting bias would diminish estimated effects of ethnic context on attitudes toward ethnic minorities in exactly the same way. Our resolution of the problem, through the use of averages from larger spatial units as instruments, has equal application in the other literature. Our results

³ Fujita (1989) describes models of equilibrium racial location patterns in situations where prejudice is important. Our procedures have the advantage of requiring no assumptions on the existence of locational equilibria.

suggest that recognition of the potential for bias in simple estimation procedures is indeed important.

Another issue which is often overlooked in this literature is the implication of sampling multiple individuals from the same geographical unit over which the ethnic density variable is defined. This leads to inferential problems which have been discussed by Moulton (1990). We address this problem by allowing for spatial group effects in the unobserved attitude components.

The structure of the paper is as follows. In Section 1 we present a model of attitudes and location decisions justifying our estimation strategy. In Section 2 we explain the nature of our data and present some simple descriptive statistics. Results are discussed in Section 3 and Section 4 concludes.

1. Attitudes and Location Choice

Suppose the area under consideration is partitioned spatially into K districts and $J > K$ smaller neighbourhoods (where the second partition represents a refinement of the first and there are therefore no overlapping boundaries). Consider the i th individual in the t th period. Let $j(it)$ denote the neighbourhood in which i has chosen to locate in period t , and let $k(it)$ denote the larger district in which $j(it)$ is located.

Denote the measured attitude of individual i at time t as A_{it} , which we take to be related to an underlying latent variable A_{it}^* capturing relevant hostility to ethnic minorities

$$A_{it} = g(A_{it}^*), \quad (1)$$

$$A_{it}^* = \alpha + \beta X_{it} + \gamma Z_{j(it)t} + \delta R_{j(it)t} + \lambda_t + \eta_{it},$$

where X_{it} denotes individual characteristics, $Z_{j(it)t}$ denotes local area characteristics and $R_{j(it)t}$ is local ethnic composition. We include time effects λ_t to allow for general trends in attitudes. The error η_{it} contains both an idiosyncratic shock, and an individual specific, unobserved attitude component, both uncorrelated with X_{it} and $Z_{j(it)t}$.

It is an equation like (1) which is usually estimated in the literature. To obtain a consistent estimate of the coefficient δ by the methods usually employed requires the assumption that $E(\eta_{it} | R_{j(it)t}) = 0$. This however is unlikely to hold if individuals can choose their neighbourhood. The locational choice will, among other things, depend on attitudes. This clearly renders the conditional expectation unequal to zero, resulting in inconsistent (and probably downward biased) estimates, as we demonstrate below.

Our estimation strategy is to use an IV estimator. Assume that individuals are free to choose their neighbourhood. In such circumstances we may suppose that local composition in the area individual i has chosen is

$$R_{j(it)t} = a + dA_{it}^* + bX_{it} + cZ_{j(it)t} + hR_{k(it)t} + V_{it}, \quad (2)$$

where $R_{k(it)t}$ is average ethnic composition of the larger district. The reduced form equation is then given by

$$R_{j(i)t} = \tilde{a} + \tilde{b}X_{it} + \tilde{c}Z_{j(i)t} + \tilde{h}R_{k(i)t} + v_{it}, \quad (3)$$

where, in particular, $v_{it} = (V_{it} + d\eta_{it})/(1 - d\delta)$. It is the correlation between v_{it} and η_{it} that is the source of the inconsistency in standard estimates of δ . Nonetheless, it may often be reasonable to assume that individuals are free to choose their neighbourhood, but are restricted to choose within the k th district. In this case, $R_{k(i)t}$ is a valid instrument for $R_{j(i)t}$ since sorting of individuals within the district will not alter the overall ethnic composition of the district.⁴

IV estimation gives us consistent estimates of δ if

$$E(\eta_{it}|R_{k(i)t}) = 0.$$

There are many reasons to believe that individuals' mobility is quite restricted outside a given geographical region. For instance, they may be restricted by the need to remain within travelling distance of place of work or desire to remain in proximity to family or friends. The above expression would not equal zero if individuals could choose their neighborhoods outside the k th spatial district *and* if this choice were driven by the unobserved attitude component in η_{it} . However, even if this were the case, we argue that instrumentation would be informative.

It is instructive to work out the bias for the two estimators. For simplicity we begin by considering a linear model rather than the latent variable model in (1).⁵ Denote the variance of η_i by σ_η^2 . Furthermore, let the conditional variance (conditional on all the other model regressors) of the local ethnic composition variable be given by $\sigma_{R_j}^2$, and the covariance between the unobserved attitude component η_{it} and the ethnic composition of the larger district $R_{k(i)t}$ be $\sigma_{\eta R_k}$. The inconsistency from estimating (1) (for a linear model) is given by

$$\text{plim}(\hat{\delta}_{OLS} - \delta) = \frac{d\sigma_\eta^2 + \tilde{h}\sigma_{\eta R_k}}{\sigma_{R_j}^2}.$$

The first term in the numerator is the conventional simultaneity bias, arising from choice of neighbourhood within district. Note that this bias will always occur if attitudes affect the choice of the ethnic composition of the neighbourhood, even if η_{it} does not contain any component correlated with $R_{k(i)t}$. If $d < 0$ (a hostile attitude leads to a choice of a neighbourhood with a lower fraction of ethnic minorities), this will clearly lead to a downward bias in the estimated coefficient $\hat{\delta}$.

The second term is the correlation between the larger district and the individual's unobserved attitude component. It would be reasonable to expect

⁴ It is this assumption that allows us to avoid the sort of identification problem discussed in Manski (1993). Of course, it is important also that $R_{k(i)t}$ should not affect attitudes directly which means that the lower level spatial unit encompasses the range of influence of ethnic composition. We are currently exploring the identification of models with more complex spatial structure.

⁵ The corresponding formula for nonlinear models is more involved, but similar and qualitatively identical observations can be shown to apply (see Dustmann and Preston (2000a) for details).

this term to equal zero if the individual were restricted to choose within the larger geographical area, unless there were some other source of correlation between unobserved characteristics and geographical location. It is likely to be negative if individuals choose also outside the larger district as a consequence of simultaneity bias arising from choice at a higher geographical level. Since $\tilde{h} > 0$, this contributes to the downward bias.

Now consider the IV estimator. The asymptotic bias is now

$$\text{plim}(\hat{\delta}_{IV} - \delta) = \frac{\tilde{h} \sigma_{\eta R_k}}{\sigma_{R_j R_k}},$$

where $\sigma_{R_j R_k}$ is the partial covariance between neighbourhood and district composition. The bias is zero if $\sigma_{\eta R_k} = 0$ as we have argued above would be reasonable if the individual were constrained to choose within the k th district.

If this were not so then there would still be inconsistency and the size of the inconsistency would depend on $\sigma_{\eta R_k}$ and therefore on the degree to which individuals were free and inclined to choose neighbourhoods outside the larger district. We might expect the inclination to do so to be low if the range of alternative ethnic compositions available by choice of location within the k th district were great enough. We show below that this variation is typically considerable.

Even for a small $\sigma_{\eta R_k}$, IV could lead to a large inconsistency if the partial covariance between $R_{j(i)t}$ and $R_{k(i)t}$, $\sigma_{R_j R_k}$, were also small. More specifically, the potential inconsistency is smaller relative to OLS the larger the partial correlation between $R_{j(i)t}$ and $R_{k(i)t}$ (see Bound *et al.* (1995) for more details).⁶ In our case, this partial correlation coefficient is substantial, as we show below. Therefore, even if our estimation procedure were not to produce consistent estimates on the effect of ethnic composition variables on attitudes, it ought nonetheless to give us some indication about the importance, and direction of sorting bias. If the choice of a neighbourhood becomes increasingly more difficult with the distance from work, friends and family, then the asymptotic bias in the estimation of δ should be reduced when we increase the size of the k th spatial district. We will use alternative spatial districts in our estimation.

All of our observed attitude indicators are discrete and ordered. We collapse indicators which have more than two categories into binary indicators (see data appendix). The choice of estimators for the model depends on the distributional assumption we are willing to make about η_{it} . We shall assume here that η_{it} is normally distributed, and choose the Probit model. We estimate the model by maximum likelihood. In so doing, we are careful to take account of the fact that the dependent variable in (3) takes the same value for all individuals sampled in the same neighbourhood. Therefore, to obtain the correct standard errors, the contributions from the instrumenting equation

⁶ The potential bias of the IV estimator is smaller than the OLS bias if $\rho_{R_j R_k} > \rho_{R_k \eta_{it}} / \rho_{R_j \eta_{it}}$, where $\rho_{R_j R_k}$, $\rho_{R_k \eta_{it}}$ and $\rho_{R_j \eta_{it}}$ are partial correlation coefficients.

ought to be counted only once per neighbourhood.⁷ The likelihood function is given in the Appendix.

We also wish to ensure robustness of our inferences to the possibility of spatial correlation in η_{it} . In the BSA, as in many other data sets used for similar analyses, sampling is multistage, so that sampled individuals are clustered within spatial units. If errors are correlated within spatial units, and regressors are grouped at the spatial level, then standard errors may be underestimated, as shown by Moulton (1986, 1990). To address this problem, we also report estimates allowing for neighbourhood level group effects. We use a finite mixture estimator with two group level mass points, which avoids imposing parametric assumptions on the structure of the correlation (see eg Aitkin and Aitkin (1996)).

2. Data

Our attitudinal data is drawn from 5 years of the British Social Attitudes Survey (1983, 1984, 1986, 1989, 1990). We use the data for England and concentrate for obvious reasons on white respondents only.⁸

The survey has extensive socioeconomic information on respondents, including education, income, age, religion, and labour market status. The data contain responses to questions on self reported prejudice and on attitudes to several specific personal or public policy issues involving racial concerns. We create binary variables for all these responses. In the Appendix, we report the full wording of the original questions.

Table 1 describes the variables used for our analysis, and reports means and standard deviations. The household income variable is reported in banded form in the data. Rather than calculating a continuous measure in units of income, we have computed the average percentage point of households in that band in the income distribution, for the specific year in which the individual is interviewed. When thinking about the effect of income on attitudes, we have in mind the effect of the relative position of the individual in the income distribution, rather than some absolute income measure. Our definition of household income seems therefore quite natural in this context.

The average age of individuals in the sample is about 46 years. Age is likely to affect attitudes towards minorities for several reasons. First, it is a direct measure of life experience, which bears a strong effect on attitudes. Second, it marks the position of the individual in his economic cycle. At some stages of this cycle, individuals' attitudes towards minorities may be more strongly affected by economic considerations. For instance, very young workers may compete for the same jobs as immigrants. Finally, the age variable captures

⁷ This amounts to regressing neighbourhood ethnic composition on neighbourhood means of characteristics. We are grateful to the referee for pointing out this issue.

⁸ Attitudes of ethnic minority individuals towards their own communities, or towards other ethnic minorities, are likely to be driven by different social mechanisms. While it might be interesting to investigate their attitudes, the sample sizes within the BSA become very small when considering attitudes of minorities only.

Table 1
Descriptive Statistics

Variable description	Mean	St.D.	Obs.
Position of HH income in distribution	0.500	0.287	4,219
Retired	0.165	0.371	4,805
Manual worker	0.442	0.496	4,573
Unemployed	0.056	0.230	4,805
Female	0.541	0.498	4,805
High education level	0.094	0.292	4,788
Low education level	0.501	0.500	4,788
Age	46.029	17.692	4,786
Catholic	0.101	0.302	4,793
No religion	0.335	0.472	4,793
Owner occupier	0.710	0.453	4,784
Council house	0.216	0.412	4,784
Unemployment Rate	0.040	0.022	4,805
Urbanisation	0.729	0.318	4,805
Opposition to ethnic minority marriage partner	0.529	0.499	3,698
Opposition to ethnic minority boss	0.198	0.398	3,734
Opposition to ethnic minority immigration	0.716	0.450	4,171
Self reported prejudice	0.381	0.485	4,764
Opposition to race discrimination law	0.302	0.459	4,637

cohort effects. The large scale settlement of ethnic minorities is a relatively recent phenomenon in the United Kingdom. We may expect individuals raised and schooled during a period when Britain had a colonial empire and the ethnic minority community was comparatively small to have developed very different opinions to those brought up in a later period when Britain's role in the world had changed and the ethnic minority population had grown much larger. Individuals who are exposed to ethnic minorities at later stages of their life may be less flexible in changing their pre-determined (and possibly negative) opinion about minorities, so that we could expect early cohorts to be less favourable to minorities than younger cohorts.

We also include dummy variables indicating whether the individual is a manual worker, in unemployment, or retired. If the skill composition of ethnic minority workers differs from the rest of the population, then we may expect them to be perceived as a different economic threat by manual and non-manual workers in the majority community. By the same token, retired individuals may be less concerned altogether by the economic impact of ethnic minorities.

We have generated two dummy variables which allocate individuals to a high education category depending upon whether they remained in education beyond age 18 and to a low education category depending upon whether they left school before age 16. Education is likely to affect attitudes for two reasons. First, higher education may help to dispel prejudices in attitudes towards individuals of different backgrounds. Second, education is likely to pick up aspects of peoples' long term prospects which are not captured by the before mentioned variables.

We have added two variables on religious beliefs. Attitude towards ethnic minorities may be influenced both by the high weight placed by many religions on the virtue of tolerance but also by any tendencies to particularism that may be associated with specific creeds. It is also possible that religious affiliation may reflect historic experiences of persecution of particular groups of the population.

Finally, we add some variables which reflect the housing tenure of the individual. It is likely that individuals in council flats are more restricted regarding their locational choice. About 22% of our sample individuals are living in council houses, and we control for that by adding a dummy variable in the regressions. We also add a dummy if an individual is an owner occupier. The rate of urbanisation may affect the contact frequency with minorities for a given concentration, as well as being associated with greater tolerance of diversity in lifestyles, as argued, for instance, by Fossett and Kiecolt (1989). We include a variable which reflects the proportion of housing in urban areas (at district level).

We have four different variables measuring attitudes. The broadest question on hostility towards ethnic minorities asks respondents directly whether they consider themselves to be prejudiced. This question also has the advantage of having the highest number of responses. However, one might worry about subjectivity in standards.

Reactions to specific issues, while more narrow, are arguably more objective. Issues dealt with include acceptability of an ethnic minority marriage partner within the close family, acceptability of an ethnic minority boss or superior at work, and support for race relations legislation. While these questions perhaps come close to measuring social acceptance of ethnic minority communities, there must be worry about contamination with other attitudes. Responses could conceivably be motivated by considerations other than simple hostility to minorities.⁹

The values for the attitude variables reveal interesting facts about the various attitude measures. The proportion of people who would be unhappy at an ethnic minority marriage partner within the family is surprisingly high, whereas opposition towards an ethnic minority boss is comparatively low.

It is interesting to see in which way these various attitude measures are related to each other. Table 2 displays the Goodman–Kruskal correlation coefficients.¹⁰ This coefficient can be interpreted as the difference in probability of like rather than unlike responses for the two measures when two individuals are chosen at random. The numbers indicate that attitudes are quite strongly correlated.

Data on ethnic composition are available from the 1981 and 1991 censuses at electoral ward level. In order to ensure compatibility between years we use

⁹ There are also questions on ethnic minority immigration, which we analyse in much detail in a separate paper (Dustmann and Preston, 2000*b*). The prominence of other issues in influencing these responses is probably greatest and makes us reluctant to concentrate on these questions in this paper.

¹⁰ This measure is computed as $\gamma = (P - Q)/(P + Q)$, where P is the number of concordant, and Q the number of discordant pairs of observations.

Table 2
Correlations of Attitudes

	Boss	Prejudice	Race Law
Marriage	0.8344 (0.019)	0.6792 (0.020)	0.4306 (0.031)
Boss		0.7485 (0.021)	0.4369 (0.035)
Prejudice			0.4126 (0.027)
Goodman-Kruskal Correlation Coefficients (Standard Errors).			

data classifying individuals by country of birth, rather than by self assessed racial group which, though arguably preferable in themselves, are available only in the later year. Ethnic minority population for our purposes, given the explicit focus of the attitudinal data on those of Asian and West Indian origin, is the population of those born in either the Indian subcontinent or in Africa or the Caribbean. We construct data for larger spatial areas by straightforward aggregation in the census data (i.e. in the population, and not in the BSA sample) and extend to intermediate years by linear interpolation. Given the skewness of the resulting distributions we take the log odds ratio of the population proportions for use in the empirical estimation.

The BSA survey was conducted by multistage sampling on an electoral ward basis. We were therefore able to match attitudinal data with census data at ward level for 1991 and 1981. Higher levels are local authority districts, counties and standard regions. We use ward level concentration as explanatory variables in our attitudes equations, with higher level concentration as instruments.

As can be seen from Table 3, the coefficient of variation in area population is fairly similar for each unit. Table 4 reports the number of each spatial unit covered by our sample, as well as the mean and the median of sample sizes within each unit. Note that, despite the small population size of each ward, we sample, on average, 18 respondents in each ward as a consequence of the multistage nature of the sample design. As pointed out above, we seek to recognise the implication of this in our estimation procedure.

Table 5 indicates that a good proportion of the variation in ethnic composition between wards is accounted for by variation between and within both districts and counties. Between area variation is important for the possibility of using area level composition as instrument, while within area variation is

Table 3
Population Sizes

Spatial unit	1981				1991			
	Median	Mean	Std.Dev.	No.	Median	Mean	Std.Dev.	No.
Ward	4,307	5,391	4,229	8,489	4,518	5,459	3,977	8,590
District	96,834	125,049	94,488	366	102,939	128,566	746,232	366
County	670,822	973,783	746,232	47	734,224	1,001,171	731,327	47

Table 4
Sample Sizes

Spatial Unit	Median	Mean	Std.Dev.	No.
Ward	18	17.40	9.73	276
District	26.5	28.85	20.83	168
County	89	111.74	123.79	43

Table 5
Spatial Decomposition

	1981		
	Overall	Between	Within
Mean	0.0166		
Std. Dev., Districts	0.0369	0.0271	0.0251
Std. Dev., Counties	0.0369	0.0167	0.0307
	1991		
	Overall	Between	Within
Mean	0.0181		
Std. Dev., Districts	0.0387	0.0297	0.0246
Std. Dev., Counties	0.0387	0.0185	0.0311

First Row: Mean across wards of proportion from ethnic minority.
 Second Row: Std.D. across wards of proportion from ethnic minority, decomposed into within and between district components. Third Row: Std.D. across wards of proportion from ethnic minority, decomposed into within and between county components.

indicative of the scope for choosing racial composition by within area location decisions.

In Figs. 1–5 we have displayed the density of ethnic minority immigrant population in Britain, and the five attitudes. All figures are at the county level. Fig. 1 indicates that the ethnic minority populations are plainly concentrated in an urban and industrialised central corridor, with particular strong concentration in the area around London, in the Midlands, and in the Northern metropolitan areas.

We use the same scale in Figs. 2–5, so that it is possible to make comparisons across figures. The differences in strength of attitudes is clearly visible from the figures. Furthermore, it is noticeable that the greatest hostility is concentrated in four areas: the area around London, the Midlands, the Northern metropolitan areas, and the Southwest. Notice that three of these are also areas where the concentration is strongest.

3. Results

We first estimate (1) using the simple probit estimator. We report marginal effects for the prejudice measure, as well as the other 3 attitude measures,

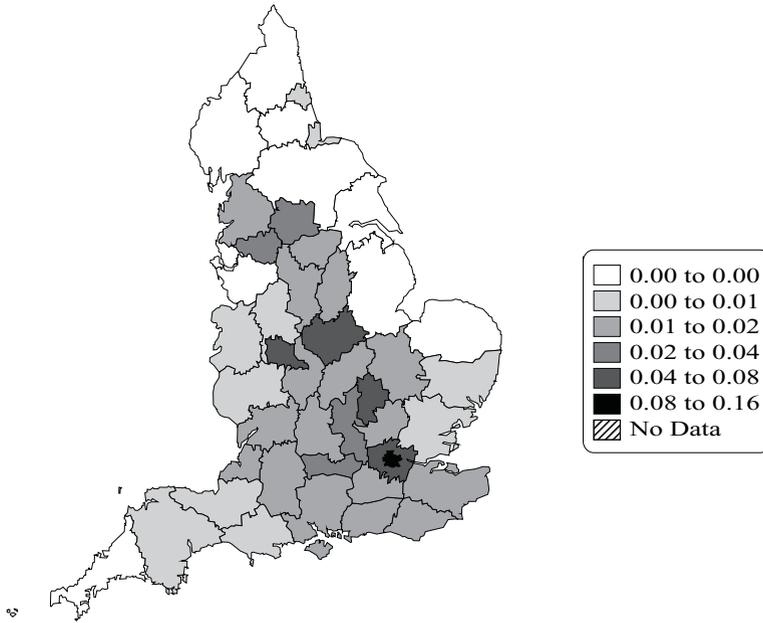


Fig. 1. *Population Density of Ethnic Minority Immigrants*

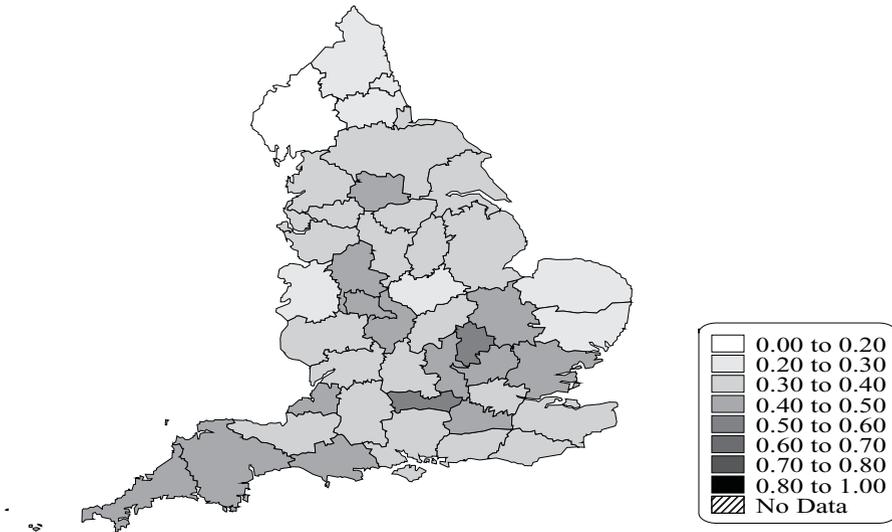


Fig. 2. *Self Reported Prejudice*

evaluated at sample means, in Table 6. All specifications include year dummies. Information on opposition to marriage with ethnic minority partner, and opposition to ethnic minority boss were not available for 1990.

We discuss first the effect of explanatory variables on self reported prejudice, and then note any salient differences for the results using the other measures.

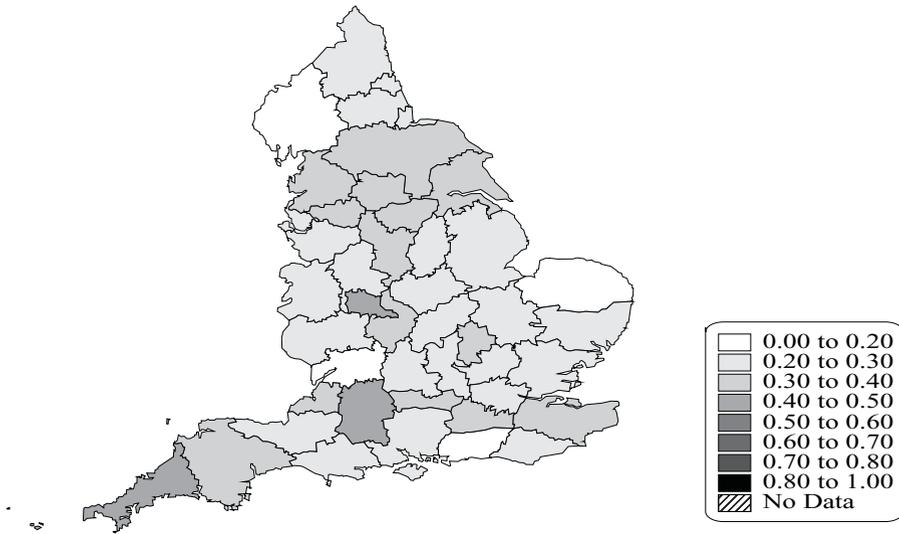


Fig. 3. *Opposition to Antidiscriminatory Legislation*

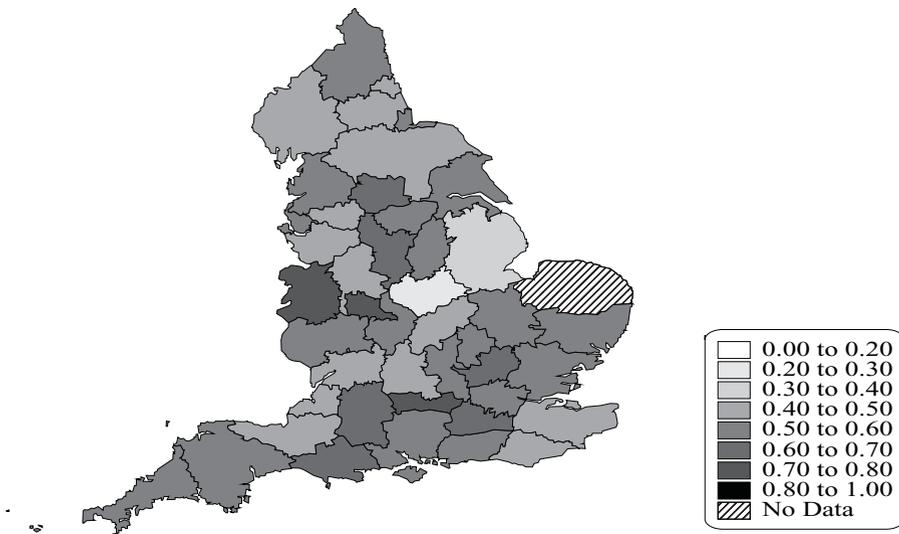


Fig. 4. *Opposition to Interethnic Marriage Within Close Family*

The higher the rank of individuals in the household income distribution, the more negative are their attitudes towards minorities, conditional on education and other labour market indicators. Individuals educated beyond age 18 have a strongly more favourable position towards minorities, and the effect is

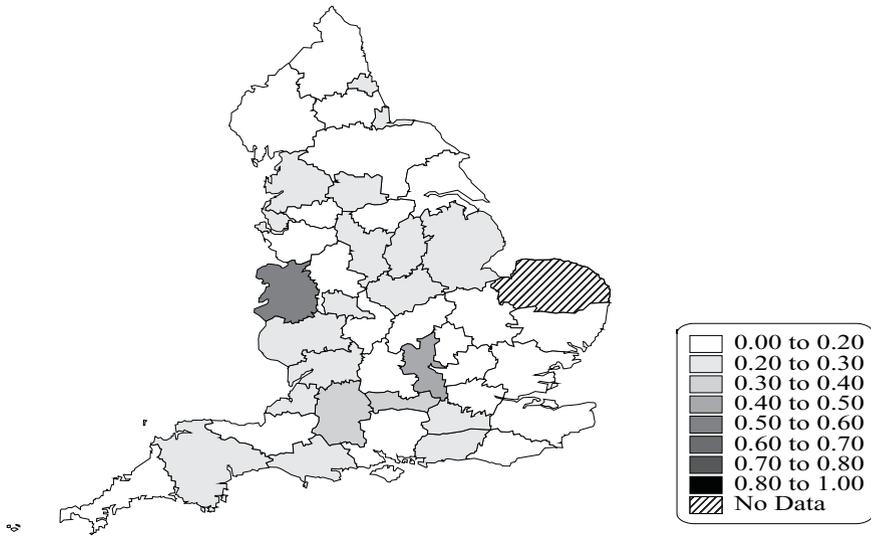
Fig. 5. *Opposition to Boss from Ethnic Minority*

Table 6
Marginal Effects, Probit

Variable	Prejudice		Marriage		Boss		Race law	
	M.E.	t-ratio	M.E.	t-ratio	M.E.	t-ratio	M.E.	t-ratio
Constant	-0.081	0.826	-0.420	3.702	-0.147	1.490	-0.498	5.022
rank income	0.095	2.404	0.102	1.935	-0.051	1.326	0.035	0.905
retired	0.030	0.882	-0.008	0.238	-0.038	1.309	0.006	0.214
manual worker	-0.026	1.377	0.044	2.081	0.010	0.604	0.026	1.498
unemployed	-0.018	0.491	-0.032	0.720	-0.054	1.413	0.021	0.637
female	-0.069	3.910	0.024	1.053	-0.031	1.842	-0.007	0.414
high education	-0.091	2.977	-0.111	2.847	-0.053	1.555	-0.152	4.849
low education	0.021	1.037	0.024	0.921	0.015	0.682	0.062	3.381
age/10	-0.006	0.930	0.057	6.331	0.007	1.121	0.028	3.831
catholic	-0.117	3.933	-0.033	0.929	-0.078	2.425	-0.041	1.327
no religion	0.007	0.415	-0.035	1.571	0.012	0.735	0.050	2.608
owner occupier	0.009	0.322	-0.007	0.191	0.011	0.343	0.015	0.523
council house	-0.060	1.891	-0.056	1.430	-0.032	0.843	0.018	0.596
urbanisation	0.015	0.535	0.061	1.517	0.065	2.060	-0.034	1.299
unempl. rate	-0.536	1.054	-0.223	0.372	-0.345	0.768	1.376	3.079
ethnic concentration	0.990	1.275	1.335	1.198	-1.395	1.524	0.714	0.928
N. obs.	3,959		3,123		3,153		3,873	

All specifications include year dummies.

very significant. Individuals in the low education category seem to tend to have more negative attitudes, although they are not significantly different from individuals with an intermediate education level. There is little evidence of any strong impact from other variables reflecting labour market status, such as manual employment, retirement or unemployment.

The two dummy variables on whether the individual is an owner occupier, or lives in council housing, have opposite sign. Council house occupiers seem to be the less prejudiced.

Women appear significantly less prejudiced than men, and catholics less prejudiced than other religious groups. We have estimated the attitude equation, including quadratic age effects. The coefficient reported in the table is the marginal effect, evaluated at the mean age. It appears that, conditional on other characteristics, age has no significant effect on prejudice.¹¹

Results for the other attitudes seems to follow a broadly similar pattern. High education, in particular, and, to a lesser extent, catholicism, maintain a strong and significant restraining effect on hostility. Age, on the other hand, does appear to be strongly associated with hostility towards interethnic marriage and race relations legislation.

We now turn to the ethnic concentration variables. The general picture emerging from the numbers in Table 6 is that a higher concentration of minorities leads to a more negative attitude towards minorities, although the effect is insignificant in all cases. The reported marginal effects are corrected so as to undo the logs odds transformation on the variable entered in the regression.¹² Accordingly, the marginal effect can be interpreted as the increase in the percentage probability of a more negative attitude if the ethnic concentration increases by 1%. All these effects are therefore quite moderate.

Consider now our simultaneous estimations. Remember that although we have no presumption about the size or sign of the ethnic context effects we expect simultaneous estimation to eliminate or mitigate a theoretically clear downward bias. Table 7 displays results where we have used ethnic concentrations at county level as instruments. In all cases but one, the effect becomes more positive. In two cases, including the prejudice variable, the precision allows one now to reject no effect.

The correlation between the error terms on location choice and attitudinal equations is negative in all cases but one, and significantly negative (at the 10% level) in two cases. In terms of our exposition in Section 2, this indicates that ordinary probit estimation of (1) involves a simultaneity bias which results in underestimates of the effect of ethnic concentration on attitudes.

As outlined above, our estimates may still be downward biased if individuals are not entirely restricted to the larger geographical district which we use as the instrument, and if unobserved attitude components affect the choice of this district. Nonetheless, bias should be reduced if the partial correlation between ward and county racial composition is strong (as we have pointed out above). Table 10 reports reduced form estimations for the prejudice equation,

¹¹ None of the terms in the polynomial are individually significant.

¹² The variable used in the regression is $\ln[\pi/(1-\pi)]$, where π is the proportion of ward population belonging to an ethnic minority. Marginal effects are the derivative of the probability with respect to π .

Table 7
Marginal Effects, Simultaneous Estimation

County as instrument								
Variable	Prejudice		Marriage		Boss		Race law	
	M.E.	t-ratio	M.E.	t-ratio	M.E.	t-ratio	M.E.	t-ratio
Constant	0.005	0.046	-0.367	2.704	-0.164	1.427	-0.416	3.711
rank income	0.092	2.329	0.100	1.876	-0.051	1.311	0.032	0.828
retired	0.027	0.808	-0.010	0.277	-0.038	1.295	0.004	0.157
manual worker	-0.024	1.286	0.045	2.140	0.010	0.584	0.027	1.584
unemployed	-0.019	0.528	-0.033	0.724	-0.053	1.407	0.019	0.581
female	-0.069	3.859	0.024	1.058	-0.031	1.836	-0.006	0.372
high education	-0.092	3.023	-0.112	2.860	-0.053	1.542	-0.154	4.871
low education	0.024	1.174	0.025	0.949	0.014	0.657	0.064	3.491
age/10	-0.007	1.018	0.057	6.308	0.008	1.125	0.027	3.732
catholic	-0.117	3.957	-0.033	0.950	-0.077	2.412	-0.041	1.329
no religion	0.007	0.395	-0.035	1.595	0.013	0.741	0.050	2.571
owner occupier	0.016	0.584	-0.004	0.100	0.010	0.310	0.022	0.780
council house	-0.055	1.732	-0.053	1.335	-0.033	0.863	0.022	0.742
urbanisation	-0.012	0.372	0.047	1.004	0.069	2.001	-0.060	1.928
unempl. rate	-0.512	0.989	-0.273	0.443	-0.332	0.729	1.404	3.100
ethnic concentration	2.539	2.161	2.299	1.330	-1.694	1.304	2.174	1.918
ρ	-0.057	1.839	-0.031	0.797	0.014	0.286	-0.060	1.833
N. obs.	3,959		3,123		3,153		3,873	

All specifications include year dummies.

where we use county level concentration as the instrument. The partial R^2 is 0.289, which is reasonably strong.¹³

We also estimated instrumenting by district level composition. Table 8 reports the main coefficients of interest, together with the other results for

Table 8
Marginal Effects

Dep. Variable	Prejudice		Marriage		Boss		Race law	
	M.E.	t-ratio	M.E.	t-ratio	M.E.	t-ratio	M.E.	t-ratio
Simple Probit								
ethnic concentration	0.990	1.275	1.335	1.198	-1.395	1.524	0.714	0.928
Simultaneous Estimation, Instrument: District								
ethnic concentration	1.907	1.781	3.144	2.204	-1.526	1.353	0.8667	0.846
ρ	-0.037	-1.184	-0.065	-1.959	0.007	0.177	-0.0068	0.218
Simultaneous Estimation, Instrument: County								
ethnic concentration	2.539	2.161	2.299	1.330	-1.694	1.304	2.174	1.918
ρ	-0.057	1.839	-0.031	0.797	0.014	0.286	-0.060	1.833

¹³ We calculate the partial R^2 as $t^2/(t^2 + n - k)$, where t is the t-ratio of the ethnic concentration variable, and $n - k$ are the degrees of freedom.

comparison. These results are generally intermediate, as we would have expected if our arguments from earlier are valid. If there is still racially motivated mobility between counties, then we would expect even the county level instrumented results to be downward biased. The county level estimates can therefore be regarded as a lower bound on the effects of ethnic concentration on attitudes within the context of the current model.

As mentioned above, if there is ward level correlation in the error in the attitude equation, and we use ethnic density at the ward level as a regressor, our standard error may be biased (see Moulton, 1986, 1990). In order to check the robustness of our results against this, we allow for neighbourhood level group effects by using a finite mixture estimator with two group level mass points. The results are reported in Table 9 which is similar to Table 8 except for the allowance for within-ward correlation. Here $\Delta\alpha$ is the estimated difference between the two possible ward level constants and p is the estimated probability of the less likely of the two. Note that evidence for the need for these ward level effects is weak since p is never significant though $\Delta\alpha$ is significant for two of the questions.¹⁴

The results regarding ethnic concentration are qualitatively similar to those in Table 8 as are the comparisons between instrumented and uninstrumented results. As expected the precision of the estimates declines – the effect is modest but since coefficients were close to the borderline of significance beforehand they come to look statistically less well determined.

Table 9
Marginal Effects, Mass Point Estimation

Dep. Variable	Prejudice		Marriage		Boss		Race law	
	M.E.	t-ratio	M.E.	t-ratio	M.E.	t-ratio	M.E.	t-ratio
Simple Probit								
ethnic concentration	0.777	0.882	1.0178	0.763	-1.523	1.526	0.463	0.496
$\Delta\alpha$	1.235	2.618	0.558	1.821	0.449	1.121	0.433	3.504
p	0.034	1.646	0.092	0.776	0.042	0.178	0.291	1.087
Simultaneous Estimation, Instrument: District								
ethnic concentration	1.376	1.213	2.735	1.645	-1.693	1.451	0.522	0.421
ρ	-0.028	0.844	-0.063	1.560	0.008	0.205	-0.002	0.060
$\Delta\alpha$	1.231	2.598	0.538	-1.650	0.450	-0.399	0.433	3.438
p	0.033	1.606	0.093	0.654	0.043	0.177	0.289	1.081
Simultaneous Estimation, Instrument: County								
ethnic concentration	2.018	1.599	1.859	0.947	-1.873	1.368	1.770	1.305
ρ	-0.050	1.470	-0.032	0.707	0.015	0.300	-0.054	1.328
$\Delta\alpha$	1.225	2.499	0.566	1.771	-0.452	0.415	0.438	2.976
p	0.033	1.590	0.092	0.735	0.042	0.184	0.245	1.000

¹⁴ Since the probability is by definition nonnegative, standard t-tests or likelihood ratio tests on $p = 0$ are inappropriate (see Shapiro (1985)).

Table 10
Reduced Form Estimates

Variable	County		District	
	Coeff.	t-ratio	Coeff.	t-ratio
Constant	0.7504	0.526	0.4657	0.379
rank income	-1.7378	-2.607	-1.7985	-3.091
retired	0.1524	0.262	0.4870	0.870
manual worker	-0.8000	-2.396	-0.8373	-2.606
unemployed	-0.2007	-0.331	0.1416	0.216
female	-0.7294	-2.211	-0.4115	-1.360
high education	-0.1940	-0.329	-0.7273	-1.421
low education	-1.2111	-3.330	-1.1802	-3.622
age/10	0.4650	0.895	0.5869	1.266
age ² /100	-3.8050	-0.682	-5.0480	-1.018
catholic	0.5054	1.488	0.5370	1.696
no religion	-0.1983	-0.583	0.2871	0.935
owner occupier	-2.3650	-4.065	-1.4010	-3.082
council house	-2.1737	-4.058	-1.4716	-3.363
% urbanised	0.6988	2.651	0.2110	0.834
unempl. rate	2.7393	0.752	-0.0562	-0.017
ethnic concentration	0.6958	11.557	0.7847	14.967
N. Obs.	350		350	
Partial R ²	0.289		0.406	

All specifications include year dummies. The dependent variable is ward level ethnic composition, and the regressor labelled as ethnic concentration is either at county or at district level. The partial R² can be interpreted as the proportion of variation in the dependent variable explained by the ethnic concentration variable, conditional on the other regressors.

4. Conclusion and Discussion

In this paper we use data from the British Social Attitude Survey for several years to analyse the effect of individual characteristics, labour market conditions, and, most importantly, local concentration of ethnic minorities on attitudes regarding minority populations. We use four different measures for attitudes, which include self assessed prejudice, attitudes towards individuals from minority populations in private and professional relations and attitudes towards race discrimination laws.

The relationship between ethnic concentration and attitudes towards minority individuals has long been an important issue in the sociological literature. This association is *ex ante* ambiguous, since high ethnic concentration may, by way of creating a perception of threat and alienation, exacerbate hostility towards minorities. Intergroup contacts may, on the other side, reduce intergroup conflicts, by way of reducing unrealistic negative perceptions of one another. In this paper, we argue that straightforward regressions may lead to biased coefficients due to spatial sorting of individuals according to their attitudes towards minorities. This bias is negative, and straightforward regressions may therefore lead to too a positive a picture of the relationship between ethnic concentration and attitudes.

Our results suggest that high concentrations of ethnic minorities, if they have any effect, probably lead to more hostile attitudes in England. Furthermore, we find a clear downward bias in estimations which regress attitude variables straightforwardly on ethnic concentration indicators. Our results point to the possibility that previous empirical evidence in this and other countries may therefore have been biased towards the contact hypothesis.

Policymakers and interest groups have long discussed the optimal settlement policy for incoming minority populations including the question of whether to encourage dispersion or concentration of such communities. Resolution of such questions requires that we be specific about the nature of the costs from the social tensions involved, that we be flexible in the specification of any nonlinearities in the relationships involved and also that we be sensitive to other social objectives and needs of the communities concerned. Any examination of the connections between high ethnic minority concentrations and hostility of the majority populations will need to address the issues raised in this paper.

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References

- Aitkin, M. and Aitkin, I. (1996) 'A hybrid EM/Gauss-Newton algorithm for maximum likelihood in mixture distributions'. *Statistics and Computing*, vol. 6, pp. 127–30.
- Binder, N. E., Polinard, J. L. and Wrinkle, R. D. (1997) 'Mexican American and Anglo attitudes toward immigration reform: a view from the border'. *Social Science Quarterly*, vol. 78, pp. 324–37.
- Black, E. and Black, M. (1973) 'The Wallace vote in Alabama: a multiple regression analysis'. *Journal of Politics*, vol. 35, pp. 730–6.
- Bound, J., Jaeger, D. A. and Baker, R. M. (1995) 'Problems with instrumental variable estimation when the correlation between the instruments and the endogenous explanatory variables is weak'. *Journal of the American Statistical Association*, vol. 90, pp. 443–50.
- Cummings, S. and Lambert, T. (1997) 'Anti-Hispanic and anti-Asian sentiments among African Americans'. *Social Science Quarterly*, vol. 78, pp. 338–53.
- Dustmann, C. and Preston, I. (2000) 'Asymptotic bias in limited dependent variable estimates with endogenous regressors', mimeo, University College London.
- Dustmann, C. and Preston, I. (2000) 'Racial and economic factors in attitudes to immigration'. CEPR Discussion Paper 2542, London: Centre for Economic Policy Research.
- Edmondston, B. and Passel, J. S. (1993) *Immigration and Ethnicity: The Integration of America's Newest Immigrants*. Washington D.C.: Urban Institute Press.
- Elkin, S. L. and Panning, W. H. (1975) 'Structural effects and individual attitudes: racial prejudice in English cities'. *Public Opinion Quarterly*, vol. 39, pp. 159–75.
- Fossett, M. A. and Kiecolt, K. J. (1989) 'The relative size of minority populations and white racial attitudes'. *Social Science Quarterly*, vol. 70, pp. 820–35.
- Frendreis, J. and Tatalovich, R. (1997) 'Who supports English-only language laws? Evidence from the 1992 National Election Study'. *Social Science Quarterly*, vol. 78, pp. 354–68.
- Fujita, M. (1989) *Urban Economic Theory: Land Use and City Size*. Cambridge: Cambridge University Press.
- Gang, I. N. and Rivera-Batiz, F. L. (1994) 'Does familiarity breed contempt? Unemployment, attitudes and foreigners in the European Union', Rutgers University Department of Economics Working Paper No 9414.
- Giles, M. W. (1977) 'Percent black and racial hostility: an old assumption reexamined'. *Social Science Quarterly*, vol. 58, pp. 412–7.
- Gran, B. K. and Hein, J. (1997) 'International migration, ethnopolitics and the French nation-state: explaining natives' views of immigrant assimilation'. *Social Science Quarterly*, vol. 78, pp. 369–84.

- Hood, M. V. and Morris, I. L. (1997) '¿Amigo o enemigo?: Context, attitudes and Anglo public opinion towards immigration'. *Social Science Quarterly*, vol. 78, pp. 309–23.
- Husbands, C. T. (1979) 'The "threat" hypothesis and racist voting in England and the United States'. In Miles and Phizacklea (1979).
- Krueger, A. and Pischke, J. S. (1997) 'A statistical analysis of crime against foreigners in unified Germany'. *Journal of Human Resources*, vol. 32, pp. 182–209.
- Manski, C. F. (1993) 'Identification of endogenous social effects: the reflection problem'. *Review of Economic Studies*, vol. 60, pp. 531–42.
- Miles, R. and Phizacklea, A. (1979) *Racism and Political Action in Britain*. London: Routledge and Kegan Paul.
- Moulton, B. R. (1986) 'Random group effects and the precision of regression estimates'. *Journal of Econometrics*, vol. 32, pp. 385–97.
- Moulton, B. R. (1990) 'An illustration of the pitfall in estimating the effects of aggregate variables on micro units'. *Review of Economics and Statistics*, vol. 72, pp. 334–8.
- Olmsted, G. (1985) 'Tiebout and the demand for local public goods.' University of Ohio, mimeo.
- Phillips, T. and Phillips, M. (1998) *Windrush: Irresistible Rise of Multi-racial Britain*, London: HarperCollins.
- Rothbart, M. and John, O. P. (1993) 'Immigration and race: recent trends.' In Edmonston and Passel (1993).
- Rubinfeld, D., Roberts, J. and Shapiro, S. (1987) 'Tiebout bias and the demand for local public schooling'. *Review of Economics and Statistics*, vol. 69, pp. 426–37.
- Schaefer, R. T. (1975) 'Regional differences in prejudice'. *Regional Studies*, vol. 9, pp. 1–14.
- Shapiro, A. (1985) 'Asymptotic distribution of test statistics in the analysis of moment structures under inequality constraints'. *Biometrika*, vol. 72, pp. 133–44.
- Sherif, M. and Sherif, C. (1953) *Groups in Harmony and Tension*. New York: Harper.
- Smith, S. J. (1989) *The Politics of 'Race' and Residence: Citizenship, Segregation and White Supremacy in Britain*. Cambridge: Polity Press.
- Stein, R. M., Post, S. S. and Rinden, A. L. (1997) 'The effect of contact and context on white attitudes toward immigrants and immigration policy'. Paper presented at the 1997 Annual Meetings of the American Political Science Association.
- Studlar, D. T. (1977) 'Social context and attitudes toward colored immigrants'. *British Journal of Sociology*, vol. 28, pp. 168–84.
- Taylor, S. (1979) 'The National Front: anatomy of a political movement.' In Miles and Phizacklea (1979).
- Tolbert, C. J. and Hero, R. E. (1996) 'Race/ethnicity and direct democracy: an analysis of California's illegal immigration initiative'. *Journal of Politics*, vol. 58, pp. 806–18.

Appendix A: Survey Questions

The measures of racial attitudes used in the paper were based on responses to the following questions:

[SRPRE]

How would you describe yourself? As very prejudiced against people of other races, a little prejudiced or not prejudiced at all?

We collapse the three possible responses into a binary variable, being equal to one if the respondent replied *very prejudiced against people of other races* or *a little prejudiced*. Only very few people identified themselves as very prejudiced (3.88% of the original sample).

[SBOSSAS/SBOSSWT]

Do you think most white people in Britain would mind or not mind if a suitably qualified person of Asian/West Indian origin were appointed as their boss? ... And you personally? Would you mind or not mind?

Respondents who admitted to minding were then asked whether they minded a lot or a little. We ignore this distinction mainly because the distinction between minding a lot and minding a little is much more subjective than the distinction between either of these and minding not at all, but also because the combined proportion was only 19.8% for Asians and 19.2% for West Indians (in the original sample). Our variable is therefore binary, being equal to one if the respondent would mind at all. Respondents were only ever asked their attitude to one or other of the two ethnic groups. We treated

a respondent as opposed when he minded a boss from either group, depending on which was asked.

[SMARAS/SMARWT]

Do you think most white people in Britain would mind or not mind if one of their close relatives were to marry a person of Asian/West Indian origin? ... And you personally? Would you mind or not mind?

Respondents who admitted to minding were then asked whether they minded a lot or a little. We ignore this distinction, again mainly because the distinction between minding a lot and minding a little is much more subjective than the distinction between either of these, and minding not at all. Our variable is therefore binary, being equal to one if the respondent would mind at all. Respondents were only ever asked their attitude to one or other of the two ethnic groups. We treated a respondent as opposed when he minded marriage to either group, depending on which was asked.

[RACELAW]

There is a law in Britain against racial discrimination, that is against giving unfair preference to a particular race in housing, jobs and so on. Do you generally support or oppose the idea of a law for this purpose?

This variable is already binary.

Appendix B: Likelihood Function

The log likelihood contribution from the j th neighbourhood is given by

$$\begin{aligned} \ln L_j = & \ln \left[\frac{1}{\sigma_R} \phi \left(\frac{\hat{v}_{jt}}{\sigma_R} \right) \right] \\ & + \ln \left\{ \sum_s p_s \sum_{i \in j} \left[\Phi \left(\frac{\mu - \alpha_s - \hat{A}_{it}^* - \rho \sigma_A \hat{v}_{jt} / \sigma_R}{\sigma_A \sqrt{1 - \rho^2}} \right) \right. \right. \\ & \left. \left. - \Phi \left(\frac{\mu_{-1} - \alpha_s - \hat{A}_{it}^* - \rho \sigma_A \hat{v}_{jt} / \sigma_R}{\sigma_A \sqrt{1 - \rho^2}} \right) \right] \right\}, \end{aligned}$$

where $\hat{v}_{jt} = R_{jt} - \tilde{a} + \tilde{b} \bar{X}_{jt} + \tilde{c} Z_{jt} + \tilde{h} R_{kt}$ and $\hat{A}_{it}^* = \beta X_{it} + \gamma Z_{jt} + \delta R_{jt} + \lambda_t$. The α_s are the mass points, and the p_s the associated probabilities. The results we report include one or two mass points, where we impose a zero normalisation on the first mass point. The standard normal density is denoted by ϕ , the standard normal distribution by Φ . The threshold coefficients (μ_{-1}, μ) equal $(-\infty, 0)$ if the observed attitude response A equals 0, and $(0, \infty)$ if this response equals 1. To find the maximised likelihood, we follow Aitkin and Aitkin (1996) and use an EM algorithm.