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Are ethnic employment penalties mitigated in deprived neighbourhoods and in ethnically dense neighbourhoods?

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Abstract

Existing research has extensively documented that those living in the most deprived neighbourhoods and individuals from some ethnic minority groups have low rates of labour market participation in the United Kingdom. This paper brings together these two established areas of research to ask whether ethnic minority groups have better employment participation when living in more deprived neighbourhoods. We hypothesise that this could be due to different socialisation processes enabling ethnic minorities to secure employment more easily in deprived neighbourhoods as well as in neighbourhoods where there is greater ethnic density. Data from the United Kingdom Household Longitudinal Study in England are linked to the Index of Multiple Deprivation 2014 and the 2011 Census to model unemployment and economic inactivity between 2009 and 2019 separately for women and men. The results show that some ethnic minority groups face disadvantage in the labour market, especially Pakistani and Bangladeshi women. There is little support to suggest that these penalties are lessened in more deprived neighbourhoods or in more ethnically dense neighbourhoods. There is some suggestion that groups who do not face ethnic penalties compared with the White British group have lower rates of unemployment and economic inactivity in more deprived neighbourhoods. We suggest policies aimed at improving labour market outcomes for disadvantaged ethnic minorities should target them wherever they live.

KEYWORDS

economically inactive, employment, ethnic density, ethnic group, neighbourhood deprivation, neighbourhood effects, UKHLS, unemployment

1 | INTRODUCTION

The assimilation of ethnic minorities has been a feature of government policy in the United Kingdom and in other countries that experienced large-scale immigration in the latter half of the 20th Century and early 21st Century (Clark et al., 2019). One successful marker of assimilation of ethnic minorities is equality of labour market outcomes, such as having a paid job. Finding employment is vital for an individual's current and future economic wellbeing as well as providing access to social integration (Birkelund et al., 2017). In the United Kingdom and elsewhere, there are a range of barriers which have made it more difficult for ethnic minorities to secure employment on an equal footing relative to the ethnic majority, including racial discrimination, spatial concentration

in deprived neighbourhoods, poor native language ability and less developed social networks (Li & Heath, 2020). These barriers can result in ethnic minorities having to make more job applications to find employment, be less likely to keep employment during periods of recession and be more likely to experience lower hourly wages and be over-qualified in employment compared with the ethnic majority (Khattab & Fox, 2016; Li & Heath, 2020). There have been attempts by United Kingdom governments to protect ethnic minorities from these barriers, perhaps most notably the watershed 1968 Race Relations Act. There has been an inherent acculturation of language among second generation ethnic minorities and a closing of educational attainment gaps compared with the White British majority, neither of which can be fully attributed to government policy, which have meant the adverse effect of being an ethnic minority has, to some extent, been offset for selected groups (Wilson et al., 2011). There is also evidence to suggest that differences in employment have narrowed in the past 30 years, however inequalities persist (Jivraj & Simpson, 2015). There is plenty of evidence showing ethnic minorities remain more likely to be unemployed relative to the white majority even when taking into account human capital and other individual characteristics thought to cause unemployment (Birkelund et al., 2017; Clark & Shankley, 2020; Khattab & Fox, 2016; Khattab & Johnston, 2013; Li & Heath, 2020). This is widely referred to as an ethnic employment penalty (Clark et al., 2019; Heath & Di Stasio, 2019; Jivraj & Khan, 2015; Li & Heath, 2020). In the United Kingdom, ethnic employment penalties remain most pronounced for the Pakistani and Bangladeshi ethnic groups (Clark et al., 2019; Li & Heath, 2020).

In a separate literature on neighbourhood effects, there is ample evidence suggesting that individuals living in more deprived neighbourhoods are more likely to be unemployed after taking into account individual factors influencing employment propensity (Brattbakk & Wessel, 2012; Dujardin & Goffette-Nagot, 2011; Manley & van Ham, 2012; Plum & Knies, 2019). Whether this is due to a causal effect is yet to be convincingly determined (Manley & van Ham, 2012). Neighbourhood effects are thought to operate through four broad processes: socialisation, environmental, geographical and institutional (Galster, 2012). The focus of this paper is primarily concerned with the social processes, positive and negative, that neighbourhoods foster to affect an individual's likelihood of employment.

It could be the case that ethnic minorities are less affected by neighbourhood effects due to neighbourhood deprivation because it is often assumed they rely more heavily on informal social networks for employment opportunities and less on formal local institutions (Battu et al., 2011; Zwysen et al., 2020). As already suggested, this potentially different socialisation experience related to employment among ethnic minorities is one of the processes through which neighbourhood effects are thought to operate (Galster, 2012). Dujardin and Goffette-Nagot (2011) hypothesise that interactions among residential neighbours are likely to affect individuals' employment through peer effects and role models which impact on the pursuit of human capital accumulation as well as attitudes to work and dissemination of job opportunities. Socialisation within a neighbourhood, unlike other neighbourhood effects processes such as place stigma, may vary by individual characteristics, including ethnicity. It is unlikely that an ethnic minority person would be any more or less likely to get a job because of the address they put on a job application ceribus paribas compared with a neighbour who is white. It could be the case that ethnic minorities have different social networks and different local institutions that they draw on compared with their white neighbours and they might not rely, at least to the same extent, on local job centres to secure employment (Andersson et al., 2014). This would reduce any negative neighbourhood effect due to neighbourhood deprivation compared with those who do rely on formal channels to encourage them to seek for and to secure employment.

One might expect that social networks used to find employment will be more widely available in neighbourhoods where there is a higher concentration of ethnic minorities. This could mean that living in neighbourhoods where ethnic minorities are more concentrated could improve labour market outcomes for ethnic minorities, which would be an inverse neighbourhood effect compared with any neighbourhood effect due to deprivation. There could also be other benefits for ethnic minorities living in ethnic minority concentrated neighbourhoods beyond an enhanced social network that can help with employment prospects. Ethnically dense neighbourhoods, typically measured using the concentration of one's own ethnic group, have shown to provide a more protected space from the negative impact of racial discrimination on poor mental health because exposure to racism is lower in these places (Astell-Burt et al., 2012; Bécares et al., 2009). This finding is not universal when taking into account experiences of racial harassment (Nandi et al., 2020). Ethnically dense neighbourhoods could provide ethnic minorities with greater confidence to continue searching for employment when they find themselves without work. We have already mentioned that in the United Kingdom, ethnic minorities tend to be concentrated in deprived neighbourhoods (Jivraj & Khan, 2015). It is therefore important to isolate the association of neighbourhood deprivation and neighbourhood ethnic density from one another to determine their independent relationship to labour market outcomes. There are few studies that have attempted to disentangle these neighbourhood processes from one another to determine an association with unemployment. The balance of evidence however does not support a reduction in unemployment propensity among ethnic minorities in areas where they are more concentrated whether neighbourhood deprivation is accounted for or not.

Clark and Drinkwater (2002) used data from the Fourth National Survey of Ethnic Minorities, 1993–1994 and the 1991 Census Sample of Anonymised Records linked to an electoral ward level measure of coethnic density in England and Wales and found no evidence that concentrated areas offer protective benefits in terms of unemployment. A limitation of this study is there was no consideration of neighbourhood deprivation as a confounder of the ethnic density and unemployment relationship. Fieldhouse (1999) used aggregate data from the 1991 Census for the London region and found equally higher unemployment rates for white groups and ethnic minority groups when living in electoral wards with a higher ethnic minority density. Zwysen and Longhi (2018) find that ethnic minorities living in local authorities in the United Kingdom with high and low proportions of coethnic density have similar ethnic employment penalties 6 months after graduation from university.

The ethnic employment penalties are not present at three and half years after graduation, except for those in the Pakistani group who are more likely to be unemployed regardless of coethnic density. Similar conclusions have been drawn in other European countries. Bauer et al. (2013) used German Socioeconomic Panel data linked to postcode region data and find the share of foreigners in the labour market has no significant impact on the individual unemployment probability of migrants, whereas the unemployment rate does, especially for second-generation migrants. Urban (2009) find that unemployment of immigrants is more strongly determined by neighbourhood economic characteristics rather than neighbourhood ethnic density using register data from Stockholm, Sweden. Neighbourhoods were defined using Statistics Sweden's small areas for market statistics (SAMS) designed to create socially homogenous areas. There is some evidence to suggest ethnic density might be protective of different labour market outcomes. For example, Andersson et al. (2014) find Swedish immigrants in three metropolitan areas experience faster labour income growth if they reside in SAMS with a higher share of coethnic minority residents and other immigrants after controlling for the share of adults employed in the neighbourhood.

This paper brings together these two established areas of research that demonstrate (1) ethnic unemployment penalties and (2) neighbourhood effects on unemployment. The main research question is whether ethnic minority groups face the same ethnic employment penalties when living in neighbourhoods that are increasingly deprived or increasingly ethnically dense. Based on theoretical literature, we test three hypotheses:

(1) Ethnic minority groups face employment penalties when holding constant the level of neighbourhood deprivation, neighbourhood ethnic density and other individual determinants of labour market disadvantage.
(2a) Ethnic minority groups face smaller employment penalties when living in more deprived neighbourhoods when holding constant the level of neighbourhood ethnic density and other individual determinants of labour market disadvantage.
(2b) Ethnic minority groups face smaller employment penalties when living in more ethnically dense neighbourhoods when holding constant the level of neighbourhood deprivation and other individual determinants of labour market disadvantage.

The current paper offers two unique contributions. First, we aim to overcome the overreliance on cross-sectional data to test differential neighbourhood effects by ethnic group on unemployment using longitudinal data over a 10-year period collected from a nationally representative sample that can be linked to small area data from the 2011 Census and Indices of Multiple Deprivation (IMD) 2015. Second, we explore the often neglected independence of neighbourhood deprivation and ethnic density on the probability of unemployment and how it differs by ethnic minority groups. We use a detailed categorisation of ethnic group that our data allow rather than restrict to crude majority versus ethnic minority dichotomisation which can dampen the extent of disadvantage experienced by some ethnic minority groups.

2 | DATA AND METHODS

This paper uses data from the United Kingdom Household Longitudinal Study (UKHLS), waves 1–9 linked to aggregate small area data on ethnic group from the 2011 Census and the IMD 2015. The data linkage was possible through a Special Licence request to the United Kingdom Data Service to use geographic identifiers in the UKHLS (ISER, 2021). The UKHLS data were collected on a roughly annual basis from a nationally representative sample of individuals living in 40,000 households, 2009–2019. Data are used for individuals aged 25–59 living in England who were part of the general population sample (added at wave 1), the ethnic minority boost sample (added at wave 1), the British Household Panel Survey sample (added at wave 2) or the immigrant and ethnic minority boost sample (added at wave 6). The analytical sample comprises more than 35,747 individuals across 154,516 person years.

2.1 | Outcome variable

Two measures of employment status (unemployed and economically inactive) are analysed separately for women and men from a question in the UKHLS which asks at each wave what best describes a respondent's current employment situation. A measure of unemployed among those economically active is derived for those who state they are currently employed (full-time or part-time as an employee, self-employed or on maternity leave) or state they are unemployed. A measure of labour market inactivity is derived for those who state they are retired, looking after family or home, sick or disabled or doing something else rather than employed or unemployed (i.e., what is commonly referred to as economically inactive). We exclude full time students from the analysis.

2.2 | Neighbourhood variables

Lower Super Output Area (LSOA) geographical identifiers are linked to neighbourhood level time-invariant measures of deprivation and ethnic density. Neighbourhood deprivation is measured using the employment domain of the IMD 2015 which measures the percentage of the working-age population in an area involuntarily excluded from the labour market (DCLG, 2015a). It was calculated from claimants of a range of out of work benefits during 2012–2014. The measure is categorised into deciles according to the national distribution where a higher value indicates a more employment deprived LSOA. A sensitivity analysis was conducted to test whether the area employment disadvantaged operates in the same way at the scale of the labour market area using out of work rates among working-age population in Travel to Work Areas (Coombes, 2010). The findings are similar to those using LSOA level employment deprivation (see Supporting Information: Appendix 1).

Coethnic density is measured using aggregate 2011 Census ethnic group data. Values of the proportion of people in each of the 18 ethnic

groups measured in the 2011 Census in a neighbourhood are matched to UKHLS respondents according to their ethnic group. For example, the value for the proportion of the Indian ethnic group in a neighbourhood is matched to UKHLS respondents who described their ethnic group as Indian. The measure is categorised into deciles according to the national distribution where a higher value indicates greater ethnic density.

We conducted the same analysis described below using a measure of ethnic diversity to aid comparison with the small part of the existing literature where ethnic diversity is used in favour of ethnic density. Ethnic diversity is measured using aggregate 2011 Census ethnic group data. It is calculated using Simpson's Reciprocal Index which measures the evenness of subgroups across all groups (Simpson & Jivraj, 2015). The values as calculated here lie between 0 and 100 where 0 indicates that all people in a neighbourhood are from the same ethnic group (i.e., no ethnic diversity) and 100 indicates all the people in a neighbourhood are distributed evenly across all ethnic groups. The findings are similar to those using a measure of ethnic density (see Supporting Information: Appendix 2).

2.3 | Moderator variable

The statistical models described below test whether the decile of neighbourhoods by their level of deprivation or ethnic density is moderated by individual ethnic group to determine whether each neighbourhood measure is more strongly related to being out of work (unemployed or inactive) for certain ethnic groups. Individual ethnic group from the UKHLS is measured using a collapsed 11-group version of the 2011 Census classification: White British, White Other, Mixed, Indian, Pakistani, Bangladeshi, Caribbean, African and Other. This collapsed version from the 18-group census measure is used to ensure sufficient sample size in each ethnic group rather than to create homogenous categories of ethnic group.

2.4 | Control variables

Several individual-level control variables are added to the statistical models described below to take account of the fact that they are known to cause differences in unemployment and are likely to determine selection into neighbourhood of residence. These are age, UK born, highest qualification and region. Individual characteristics that might be caused by rather than cause either employment status or neighbourhood of residence, such as health status, children in the household, unpaid caring and relationship status are not included in the analysis because of their potential collider rather than confounding effect.

Age is measured in years. UK born (yes/no) is dichotomised. Highest qualification is categorised into five groups: degree, A-level, GCSE or lower, other qualifications and no qualifications. Region of residence is measured using the nine Government Office Region boundaries in England.

2.5 | Statistical model

Logistic regression models are estimated separately by sex and for unemployment and inactivity over nine waves of UKHLS using Stata 17. Standard errors across waves are clustered at the individual level. Mixed effects models considering the clustering of respondents within survey wave struggled to converge when estimating the marginal effects by ethnic group. When these models did converge, it was not possible to calculate standard errors of the margin. The point estimates of the marginal effects are substantively similar to those from the single-level models presented below when fitting multilevel models limited to 25 iterations.

The statistical models include continuous terms for the decile of neighbourhood deprivation and the decile of neighbourhood ethnic density as well as controlling for time-constant and time-varying confounding variables. The time-constant variables, measured at the baseline wave when a sample member entered UKHLS are UK born, education and ethnic group. The time-varying variables are age and region.

Interaction terms between individual ethnic group and either neighbourhood deprivation or neighbourhood ethnic density are added to the models separately. The interaction terms provide a test of the main research question in this paper: does individual ethnic group moderate neighbourhood effects.

The analysis utilises UKHLS weights for nonproxy respondents for each wave, giving zero-weight for no longer eligible groups (e.g., temporary residents). A complete case sample is used at each wave because the level of item-missingness was no more than 2% across all variables. The UKHLS sample sources varied over waves 1–9. There are 19,960 respondents at wave 1 from the general population sample and 4098 from the ethnic minority boost sample. Less than half were followed-up to wave 9, 41% in the general population sample and 32% in the ethnic minority boost sample. There were 2908 British Household Panel Survey respondents added at wave 2. The sample attrition rate up to wave 9 was 40% of the sample. A new immigrant and ethnic minority boost sample of 1796 respondents was added at wave 6 of which 51% were followed-up to wave 9. The vast majority of attrition in the study sample was due to refusal to participate rather than a recorded ineligibility to participate (e.g., registered death or emigration). Being an ethnic minority (except Pakistani and Bangladeshi) and foreign born are independent predictors of attrition between waves 1 and 9 in the general population sample (see Supporting Information: Appendix 5).

3 | RESULTS

3.1 | Sample characteristics

Table 1 shows the weighted characteristics of the UKHLS analytical sample for those aged 25–59 living in England at waves 1–9 by sex. The percentage of women unemployed decreased from 7.01% at wave 1 (2009–2011) to 5.08% by wave 9 (2018–2020). A similar level of decline is seen in men from 9.34% at wave 1 to 5.58% at

TABLE 1 Complete case analytical sample characteristics, UKHLS wave 1–9.

Women	Wave 1 [*n* = 13,618]	Wave 2 [*n* = 12,655]	Wave 3 [*n* = 10,743]	Wave 4 [*n* = 9706]	Wave 5 [*n* = 8879]	Wave 6 [*n* = 9573]	Wave 7 [*n* = 8665]	Wave 8 [*n* = 7722]	Wave 9 [*n* = 6828]	Total [*n* = 88,378]
Outcome variables										
Unemployed[a]	7.01%	6.56%	6.41%	5.80%	5.71%	5.54%	5.42%	4.41%	5.08%	5.88%
Economically inactive	21.58%	20.81%	19.76%	19.17%	18.77%	18.36%	17.81%	18.16%	16.65%	19.25%
Neighbourhood decile										
Employment deprivation	5.45 (2.84)	5.49 (2.83)	5.51 (2.82)	5.51 (2.81)	5.51 (2.82)	5.51 (2.84)	5.51 (2.85)	5.52 (2.85)	5.53 (2.84)	5.5 (2.83)
Coethnic density	6.36 (2.75)	6.31 (2.76)	6.33 (2.74)	6.33 (2.73)	6.32 (2.72)	6.25 (2.69)	6.29 (2.71)	6.28 (2.71)	6.24 (2.73)	6.31 (2.73)
Ethnic diversity	5.67 (2.83)	5.59 (2.83)	5.61 (2.82)	5.6 (2.81)	5.6 (2.8)	5.46 (2.77)	5.49 (2.79)	5.45 (2.8)	5.48 (2.81)	5.56 (2.81)
Individual variables										
Ethnic group										
White British	82.05%	83.74%	83.12%	83.19%	83.20%	84.93%	84.14%	84.58%	85.03%	83.66%
White other	5.71%	5.49%	5.76%	5.65%	5.47%	4.59%	4.99%	4.62%	4.43%	5.26%
Mixed	1.33%	1.33%	1.38%	1.45%	1.51%	1.38%	1.42%	1.47%	1.57%	1.41%
Indian	2.83%	2.60%	2.50%	2.59%	2.55%	2.23%	2.30%	2.26%	2.19%	2.48%
Pakistani	1.61%	1.46%	1.56%	1.43%	1.45%	1.18%	1.30%	1.33%	1.25%	1.41%
Bangladeshi	0.55%	0.50%	0.49%	0.48%	0.56%	0.55%	0.60%	0.64%	0.69%	0.55%
Caribbean	1.40%	1.16%	1.28%	1.26%	1.26%	1.07%	1.09%	1.10%	1.04%	1.20%
African	2.03%	1.56%	1.70%	1.61%	1.68%	1.64%	1.74%	1.69%	1.68%	1.71%
Other	2.50%	2.16%	2.22%	2.33%	2.32%	2.44%	2.41%	2.31%	2.12%	2.31%
Age	41.8 (9.75)	412.0 (9.72)	42.4 (9.66)	42.6 (9.81)	42.6 (9.78)	42.9 (9.81)	43.0 (9.87)	43.1 (9.91)	43.3 (10.05)	42.5 (9.81)
Overseas born	15.41%	13.65%	14.19%	14.08%	13.92%	12.33%	12.92%	12.54%	11.94%	13.58%
Highest qualification										
Degree	43.51%	43.00%	45.31%	46.42%	47.11%	47.25%	48.29%	48.34%	48.68%	46.08%
A-level etc	16.51%	17.43%	17.24%	17.37%	17.94%	17.70%	17.96%	18.53%	19.05%	17.64%
GCSE etc	22.76%	22.95%	22.24%	22.00%	21.73%	22.12%	21.69%	21.55%	21.39%	22.14%
Other qualification	8.68%	9.06%	8.48%	8.04%	7.61%	7.74%	7.32%	7.20%	7.03%	8.03%
No qualification	8.53%	7.57%	6.73%	6.16%	5.61%	5.19%	4.74%	4.38%	3.85%	6.11%

(Continues)

TABLE 1 (Continued)

Women	Wave 1 [*n* = 13,618]	Wave 2 [*n* = 12,655]	Wave 3 [*n* = 10,743]	Wave 4 [*n* = 9706]	Wave 5 [*n* = 8879]	Wave 6 [*n* = 9573]	Wave 7 [*n* = 8665]	Wave 8 [*n* = 7722]	Wave 9 [*n* = 6828]	Total [*n* = 88,378]
Region										
North East	5.11%	5.07%	5.10%	5.13%	5.19%	5.54%	5.33%	5.19%	5.25%	5.20%
North West	13.01%	13.55%	13.33%	13.32%	13.11%	13.20%	12.84%	12.77%	12.83%	13.14%
Yorkshire and the Humber	9.72%	9.93%	9.90%	10.09%	10.13%	10.45%	10.51%	10.54%	10.20%	10.13%
East Midlands	8.38%	8.77%	8.64%	8.94%	9.01%	9.24%	9.22%	9.23%	9.36%	8.93%
West Midlands	10.19%	10.05%	10.30%	10.09%	10.13%	10.05%	10.41%	10.54%	10.54%	10.23%
East of England	10.98%	11.34%	11.24%	11.45%	11.43%	11.58%	11.27%	11.50%	11.30%	11.33%
London	16.61%	14.92%	15.20%	15.27%	15.19%	13.13%	14.12%	13.98%	14.50%	14.86%
South East	16.24%	16.66%	16.37%	15.99%	15.92%	16.51%	16.37%	16.05%	15.97%	16.26%
South West	9.77%	9.70%	9.90%	9.71%	9.89%	10.31%	9.94%	10.19%	10.06%	9.92%
Men	**Wave 1 [*n* = 10,440]**	**Wave 2 [*n* = 9697]**	**Wave 3 [*n* = 8179]**	**Wave 4 [*n* = 7387]**	**Wave 5 [*n* = 6853]**	**Wave 6 [*n* = 7375]**	**Wave 7 [*n* = 6636]**	**Wave 8 [*n* = 6042]**	**Wave 9 [*n* = 5280]**	**Total [*n* = 67,889]**
Outcome variables										
Unemployed[a]	9.34%	8.43%	8.09%	7.25%	6.72%	5.91%	5.84%	5.82%	5.58%	7.23%
Economically inactive	7.72%	7.44%	7.63%	7.20%	7.33%	7.52%	7.25%	7.86%	8.29%	7.56%
Neighbourhood decile										
Employment deprivation	5.44 (2.84)	5.47 (2.83)	5.47 (2.82)	5.44 (2.81)	5.46 (2.82)	5.42 (2.82)	5.44 (2.85)	5.43 (2.85)	5.46 (2.85)	5.45 (2.83)
Coethnic density	6.32 (2.81)	6.29 (2.79)	6.33 (2.77)	6.31 (2.78)	6.25 (2.78)	6.23 (2.72)	6.23 (2.74)	6.17 (2.76)	6.17 (2.75)	6.27 (2.77)
Ethnic diversity	5.79 (2.87)	5.61 (2.86)	5.61 (2.85)	5.63 (2.85)	5.63 (2.83)	5.45 (2.78)	5.51 (2.8)	5.52 (2.81)	5.5 (2.81)	5.6 (2.83)
Individual variables										
Ethnic group										
White British	81.63%	84.13%	83.67%	83.63%	84.31%	85.88%	85.67%	85.93%	86.59%	84.37%
White Other	5.11%	5.53%	5.19%	5.11%	4.62%	4.40%	4.31%	4.49%	3.94%	4.83%
Mixed	1.04%	0.87%	1.08%	1.13%	1.20%	1.20%	1.19%	1.20%	1.12%	1.10%
Indian	3.60%	3.00%	3.20%	3.16%	3.16%	2.61%	2.68%	2.57%	2.59%	3.00%
Pakistani	1.92%	1.47%	1.61%	1.49%	1.59%	1.14%	1.28%	1.27%	1.27%	1.48%
Bangladeshi	0.90%	0.72%	0.74%	0.82%	0.71%	0.67%	0.73%	0.67%	0.75%	0.75%
Caribbean	1.14%	0.83%	0.93%	0.99%	0.81%	0.63%	0.69%	0.71%	0.71%	0.85%

TABLE 1 (Continued)

Men	Wave 1 [*n* = 10,440]	Wave 2 [*n* = 9697]	Wave 3 [*n* = 8179]	Wave 4 [*n* = 7387]	Wave 5 [*n* = 6853]	Wave 6 [*n* = 7375]	Wave 7 [*n* = 6636]	Wave 8 [*n* = 6042]	Wave 9 [*n* = 5280]	Total [*n* = 67,889]
African	1.86%	1.34%	1.44%	1.46%	1.36%	1.20%	1.27%	1.20%	1.17%	1.39%
Other	2.79%	2.11%	2.15%	2.21%	2.25%	2.27%	2.18%	1.98%	1.85%	2.23%
Age	41.6 (9.81)	42.0 (9.89)	42.3 (9.83)	42.3 (9.84)	42.8 (9.80)	42.9 (9.991)	43.0 (9.99)	43.2 (10.02)	43.4 (10.01)	42.5 (9.90)
Overseas born	16.41%	13.25%	13.78%	13.83%	13.33%	11.59%	11.78%	11.34%	10.60%	13.15%
Highest qualification										
Degree	42.58%	40.65%	42.20%	43.52%	43.91%	43.30%	44.21%	44.97%	45.46%	43.18%
A-level etc	19.62%	21.85%	21.42%	21.62%	21.87%	22.36%	22.35%	22.23%	22.30%	21.62%
GCSE etc	20.14%	21.08%	21.26%	21.09%	20.91%	21.08%	20.97%	20.83%	21.08%	20.92%
Other qualification	10.28%	10.13%	9.61%	9.03%	8.71%	8.85%	8.23%	8.23%	7.90%	9.15%
No qualification	7.38%	6.29%	5.51%	4.74%	4.60%	4.41%	4.24%	3.74%	3.27%	5.13%
Region										
North East	5.12%	4.94%	5.13%	5.04%	5.22%	5.59%	5.53%	5.17%	5.18%	5.20%
North West	12.96%	13.32%	13.18%	12.83%	13.04%	13.28%	13.20%	13.26%	13.43%	13.15%
Yorkshire and the Humber	9.65%	9.81%	9.79%	9.80%	10.28%	10.63%	10.51%	10.91%	10.68%	10.15%
East Midlands	8.39%	9.18%	9.04%	9.32%	9.08%	9.45%	9.13%	9.04%	9.07%	9.06%
West Midlands	10.11%	10.13%	10.30%	9.91%	9.89%	9.94%	9.67%	9.56%	9.70%	9.95%
East of England	10.98%	11.12%	11.40%	11.50%	11.69%	11.59%	11.42%	11.32%	11.27%	11.35%
London	17.11%	15.30%	15.09%	15.69%	15.33%	13.28%	14.01%	14.64%	14.34%	15.10%
South East	15.95%	16.12%	15.85%	15.57%	15.22%	15.76%	16.18%	15.83%	15.99%	15.84%
South West	9.72%	10.08%	10.21%	10.34%	10.26%	10.48%	10.35%	10.26%	10.34%	10.20%

Abbreviation: UKHLS, United Kingdom Household Longitudinal Study.

[a]sample size contains economic active only.

wave 9. The percentage of women economically inactive decreased from 21.58% at wave 1 to 16.65% by wave 9. The percentage of men economically inactive remained constant at 7%–8% between wave 1 and wave 9. These results follow similar trends reported from the Labour Force Survey (Leaker, 2023). The mean neighbourhood employment rate decile and the mean ethnic density decile in women and men aged 25–59 both remained constant over the 9 study waves. This suggests either or both a balancing out of stability in the spatial distribution of respondents or nonselective attrition according to these neighbourhood characteristics. The percentage of ethnic minority women and men decreased from around 18% at wave 1 to 15% at wave 9. This reflects the higher attrition rate among ethnic minorities in the UKHLS.

3.2 | Unemployment

Table 2 shows the main effect model results of unemployment by individual ethnic group and by neighbourhood deprivation decile and ethnic density decile in women. The full model results are available in Supporting Information: Appendix 6. The estimates are odds ratios of being unemployed. Women in all ethnic minority groups except the Other White group are more likely to be unemployed compared with the White British group, while holding constant control variables. The difference is not statistically significant for Indian or Bangladeshi women. The significant odds across ethnic minority women are between 1.49 in the Other group to 2.99 in the Pakistani group compared with the White British group. The main effect for neighbourhood deprivation in women, irrespective of ethnic group, shows that for each unit increase in the decile of neighbourhood deprivation, the odds of unemployment increases by 1.17 times. The main effect association between neighbourhood ethnic density and unemployment is not statistically significant.

The main effect findings for unemployment are similar in men (see Table 3). Mixed, Caribbean and African men are at least two times more likely to be unemployed compared with White British men. In contrast to women, there is not a significant difference between men in the Pakistani group compared with men in the White British group. The odds in men of being unemployed, independent of ethnic group in the main effects model, is 1.24 times greater for each unit increase in the neighbourhood deprivation decile. The main effect for neighbourhood ethnic density shows unemployment in men is almost 5% lower for each unit increase in the ethnic density decile.

Figures 1a,b show the marginal difference between predicted probabilities of unemployment for each ethnic minority group compared with the White British group by the neighbourhood deprivation decile and neighbourhood ethnic density decile, respectively. The marginal effects are calculated from a model including an interaction term between individual ethnic group and neighbourhood deprivation decile or neighbourhood ethnic density decile. The horizontal red line at zero on each plot indicates whether the point estimate of difference to the White British group is positive or negative. The confidence intervals indicate whether the difference is statistically significant. To confirm the hypotheses that ethnic minority groups living in more deprived neighbourhoods and in more ethnically dense neighbourhoods face smaller ethnic penalties, one would expect a downwards sloping gradient from lower to higher deciles.

In women, there is a suggestion of a small protective effect of living in more deprived neighbourhoods for the Other White group (see Figure 1a). There was no evidence of an ethnic employment penalty in

TABLE 2 Odds ratios of unemployment in women by ethnic group and neighbourhood decile.

	Odds ratio	*p* Value	95% CIs Lower bound	95% CIs Upper bound
White group (ref: White British)				
White Other	1.004	0.981	0.733	1.376
Mixed	1.614	0.011	1.118	2.328
Indian	1.346	0.087	0.958	1.892
Pakistani	2.991	0.000	2.147	4.168
Bangladeshi	1.358	0.124	0.919	2.007
Caribbean	2.420	0.000	1.645	3.559
African	1.512	0.011	1.098	2.082
Other	1.490	0.025	1.052	2.110
Neighbourhood decile				
Employment deprivation	1.170	0.000	1.142	1.198
Coethnic density	0.995	0.695	0.971	1.020

Note: Adjusted for age, sex, UK born, education level and region.

TABLE 3 Odds ratios of unemployment in men by ethnic group and neighbourhood decile.

	Odds ratio	*p* Value	95% CIs Lower bound	95% CIs Upper bound
White group (ref: White British)				
White Other	1.485	0.070	0.968	2.278
Mixed	2.395	0.001	1.398	4.103
Indian	1.369	0.079	0.965	1.942
Pakistani	1.256	0.208	0.881	1.792
Bangladeshi	1.645	0.015	1.101	2.458
Caribbean	3.211	0.000	2.207	4.673
African	3.393	0.000	2.321	4.960
Other	1.855	0.004	1.223	2.814
Neighbourhood decile				
Employment deprivation	1.241	0.000	1.210	1.274
Coethnic density	0.954	0.001	0.928	0.981

Note: Adjusted for age, sex, UK born, education level and region.
Abbreviation: CI, confidence interval.

Other White women for those living in neighbourhoods in the least deprived decile. However, those living in the most deprived decile of neighbourhoods are predicted to have an unemployment rate that is 2.54% points lower than White British women. The predicted ethnic penalty across neighbourhood deprivation deciles is opposite for the Caribbean women. The ethnic employment penalty in Caribbean women is absent for those living in the least deprived neighbourhoods, whereas it rose to 12.36% points in the most deprived neighbourhoods. For women in all other ethnic minority groups, there was no suggestion of a different marginal effect across deciles of neighbourhood deprivation compared with the White British group.

The point estimates suggest that women in almost all ethnic minority groups are predicted to have higher predicted probabilities of unemployment when living in more ethnic dense neighbourhoods (see Figure 1b). The interaction is strongest and is only significant for the Other ethnic group. The predicted difference in the probability of unemployment in Other ethnic group women compared with White British women is −2.23% points lower in the least ethnically dense decile of neighbourhoods compared with 3.96% points higher in the most ethnically dense decile of neighbourhoods.

In men, we find evidence of different ethnic employment penalties for selected ethnic groups across levels of neighbourhood deprivation (see Figure 2a). Bangladeshi men living in the least deprived decile of neighbourhoods are predicted to have an unemployment rate 7.03% points higher compared with the White British group, whereas their unemployment penalty is predicted to be

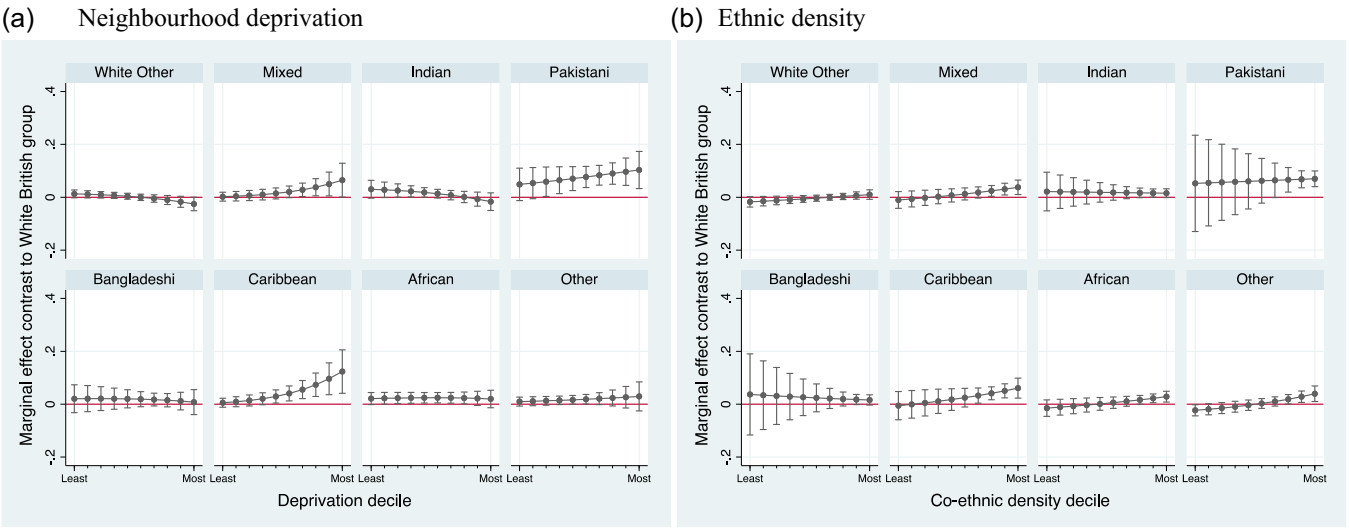

FIGURE 1 Marginal effect off predicted probability of unemployment in women compared with the White British group. (a) Neighbourhood deprivatio. (b) Ethnic density.

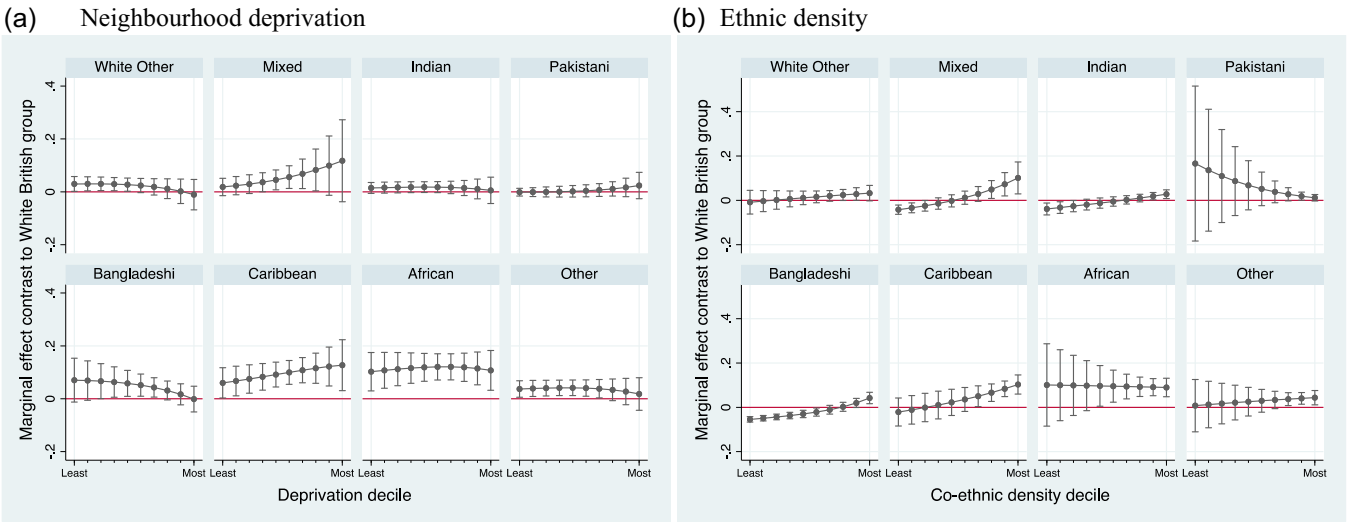

FIGURE 2 Marginal effect of predicted probability of unemployment in men compared with the White British group. (a) Neighbourhood deprivation. (b) Ethnic density.

zero when living in the most deprived decile of neighbourhoods. The differential association with unemployment across deciles of neighbourhood deprivation follows a similar trend in White Other, African and Other men.

There are differential relationships in the unemployment in men by neighbourhood ethnic density for some ethnic minority men (see Figure 2b). Mixed, Indian, Bangladeshi and Carribbean men are all more likely to be unemployed compared with White British men when living in the most ethnically dense neighbourhoods but are equally likely (Caribbean) or less likely (Mixed, Indian and Bangladeshi) to be unemployed in the least ethnically dense neighbourhoods.

3.3 | Labour market inactivity

Table 4 shows the main effect model results of labour market inactivity by individual ethnic group and by neighbourhood deprivation decile and ethnic density decile in women. The estimates are odds ratios of being economically inactive. Women in ethnic groups that include people of South Asian origin (i.e., Indian, Pakistani, Bangladeshi and Other groups) had predicted probabilities of economic inactivity higher than the White British group while holding constant other variables in the model. Indian women and women in the Other ethnic group are around 1.5 times more likely whereas Bangladeshi women and Pakistani women are 3.07 and 4.20 times more likely, respectively, to be economically inactive compared with White British women. In contrast, women in the Caribbean group are more than 38% less likely to be economically inactive compared with White British women.

In the main effects model, irrespective of ethnic group, there are higher odds of economic inactivity in women when living in each more deprived decile of neighbourhoods by 1.08 times. There is not a statistically significant association between the decile of ethnic density and the probability of unemployment in women (Table 4).

In men, no ethnic minority group had a significant difference in the probability of economic inactivity compared with the White British group, except for Mixed group men who are almost two times more likely to be economically inactive. Men living in a more deprived decile of neighbourhoods, irrespective of ethnic group, are 1.18 times more likely to be economically inactive. There is not a statistically significant association between the level of ethnic density and economic inactivity in men (Table 5).

Figures 3a,b shows the marginal difference between predicted probabilities of economic inactivity in women for each ethnic minority group compared to White British women by neighbourhood deprivation decile and neighbourhood ethnic density decile, respectively. There is evidence of a deleterious effect of neighbourhood deprivation on the magnitude of the ethnic inactivity penalty in Pakistani women. Pakistani women living in the least deprived decile of neighbourhoods are predicted to have an economic inactivity penalty of 12.23% points compared with 35.35% points when living in the most deprived neighbourhoods. In contrast, there is evidence of a protective effect of neighbourhood deprivation on the economic inactivity penalty in women in the White Other and Other groups. Women in the Other ethnic group are predicted to have an economic inactivity penalty of 14.04% points when living in the least deprived neighbourhoods compared with −2.26% points when living in the most deprived neighbourhoods.

TABLE 4 Odds ratios of economic inactivity in women by ethnic group and neighbourhood decile.

	Odds ratio	*p* Value	95% CIs	
			Lower bound	Upper bound
White group (ref: White British)				
White other	0.838	0.189	0.644	1.091
Mixed	0.944	0.677	0.720	1.237
Indian	1.346	0.014	1.063	1.704
Pakistani	4.201	0.000	3.359	5.254
Bangladeshi	3.070	0.000	2.284	4.126
Caribbean	0.620	0.001	0.466	0.825
African	0.956	0.771	0.705	1.295
Other	1.525	0.004	1.146	2.028
Neighbourhood decile				
Employment deprivation	1.075	0.000	1.058	1.092
Coethnic density	1.012	0.182	0.994	1.030

Note: Adjusted for age, sex, UK born, education level and region.
Abbreviation: CI, confidence interval.

TABLE 5 Odds ratios of economic inactivity in men by ethnic group and neighbourhood decile.

	Odds ratio	*p* Value	95% CIs	
			Lower bound	Upper bound
White group (ref: White British)				
White other	1.591	0.064	0.973	2.600
Mixed	1.897	0.028	1.071	3.360
Indian	0.857	0.516	0.537	1.366
Pakistani	1.125	0.612	0.714	1.774
Bangladeshi	1.367	0.256	0.797	2.346
Caribbean	1.362	0.204	0.845	2.196
African	1.251	0.565	0.584	2.678
Other	1.335	0.308	0.767	2.325
Neighbourhood decile				
Employment deprivation	1.174	0.000	1.140	1.210
Coethnic density	1.002	0.923	0.970	1.034

Note: Adjusted for age, sex, UK born, education level and region.

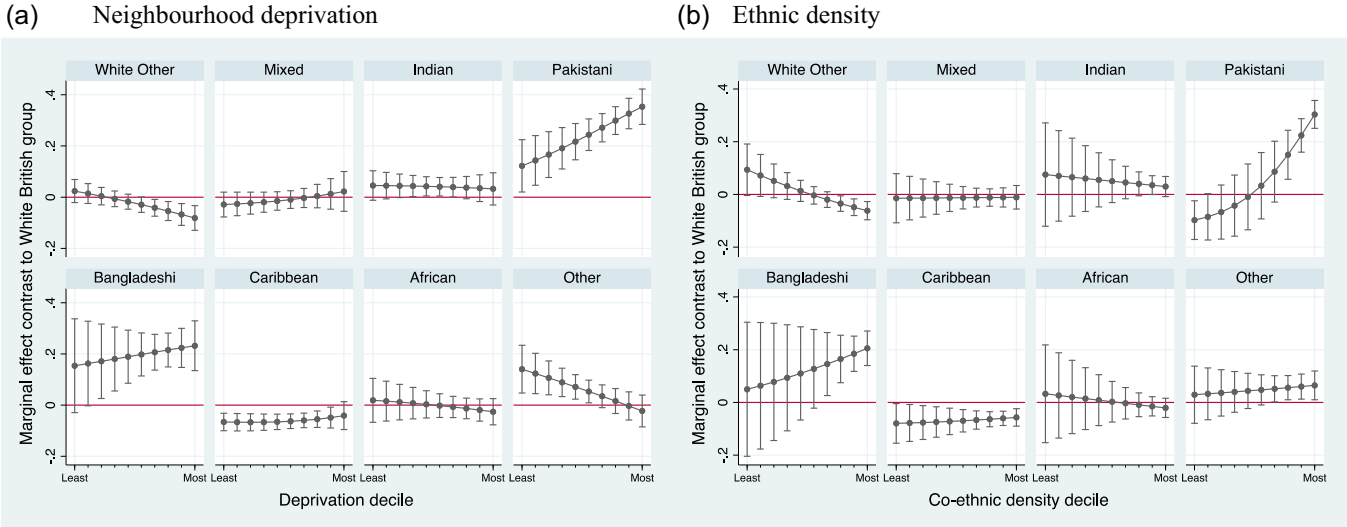

FIGURE 3 Marginal effect of predicted probability of economic inactivity in women compared with the White British group. (a) Neighbourhood deprivation. (b) Ethnic density.

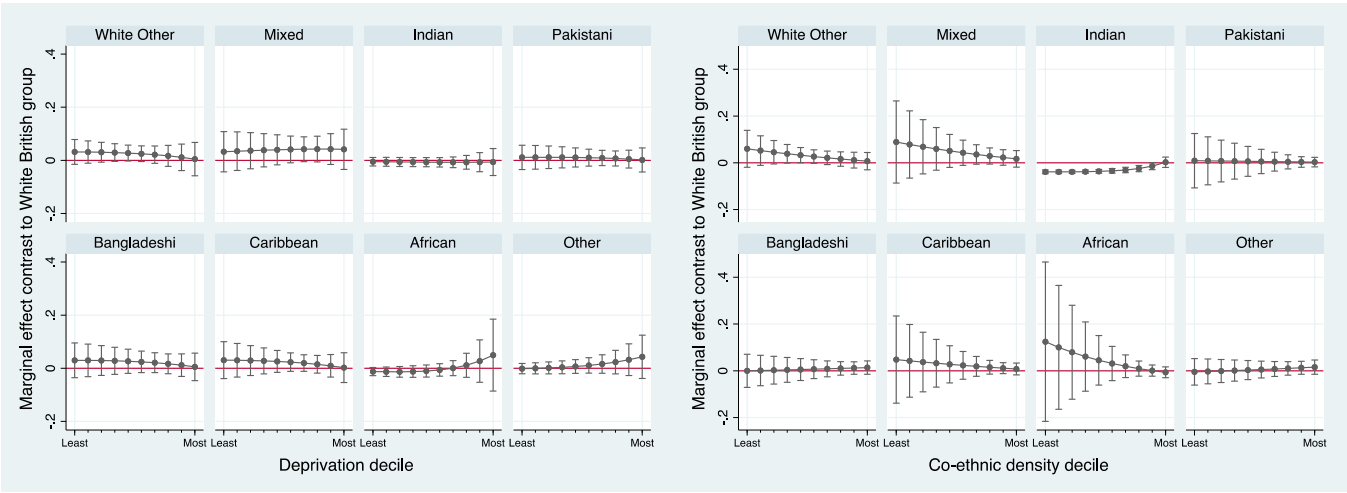

FIGURE 4 Marginal effect of predicted probability of economic inactivity in men compared with the White British group. (a) Neighbourhood deprivation. (b) Ethnic density.

There is also a divergence between some ethnic minority groups in women of differential economic inactivity penalties by the level of neighbourhood ethnic density. Pakistani women have considerably greater ethnic penalties when living in more ethnically dense neighbourhoods, whereas Other White women have a greater economic inactivity advantage when living in more ethnically dense neighbourhoods. The predicted difference in the probability of economic inactivity in Pakistani women is −9.75% points in the least ethnically dense decile of neighbourhoods compared with 30.36% points in the most ethnically dense decile of neighbourhoods. In contrast, Other White women had an economic inactivity rate 9.39% points higher than White British women when living in the least ethnically dense decile of neighbourhoods compared with 6.15% points lower in the most ethnically dense decile of neighbourhoods Figure 3.

There are no significant differences in predicted economic inactivity for male ethnic minority groups compared with the White British groups across neighbourhood deprivation deciles. The same is the case for predicted economic inactivity by neighbourhood ethnic density decile, except for Indian men who are marginally more likely to be economic inactive compared with White British men when living in more ethnically dense neighbourhoods (see Figure 4).

4 | DISCUSSION

The clearest finding from this paper is that working aged women in Pakistani and Bangladeshi ethnic groups are considerably more likely to be outside of the labour market in England compared with

White British women. The difference in the rate of economic inactivity (i.e., the ethnic employment penalty) faced by Pakistani women is more than four times higher when taking into account the neighbourhood deprivation, neighbourhood ethnic density, age, UK nativity, education and region of residence. This is not a novel finding. There is evidence from multiple data sources over the past 30 years showing Pakistani and Bangladeshi women are disadvantaged in terms of access to the labour market (Khattab & Johnston, 2013; Li & Heath, 2020). It could be due to a pressure on many Pakistani and Bangladeshi women in the United Kingdom to maintain traditional gender roles in the household which creates a barrier to seeking paid work (Dale et al., 2002, 2006). Pakistani and Bangladeshi women who are able to seek for work face perceived stereotyping that they believe raises doubts in recruiters at job interviews (Dale et al., 2002).

We find less severe evidence of ethnic employment penalties for other ethnic minority groups in both women and men. Women in the Mixed, Pakistani, Caribbean and African ethnic groups are at least one and half times more likely to be unemployed and looking for work compared with White British women. Men in the Mixed, Bangladeshi, Caribbean and African and Other groups are at least one and half times more likely to be unemployed and looking for work. The ethnic penalty estimate of unemployment for Caribbean and African men is more than three times likely to be unemployed compared with White British men. Women in the Indian and Other ethnic groups are one and half times more likely to be economically inactive compared with White British women. Men in the Mixed ethnic group are almost two times more likely to be economically inactive compared with White British men. These findings provide partial confirmation of our first hypothesis that ethnic minority groups face employment penalties once taking into account individual and neighbourhood factors.

The main hypotheses of this paper are to determine whether these ethnic employment penalties differ by neighbourhood deprivation and neighbourhood ethnic density. The proposed mechanism for these hypotheses are potential different socialisation processes that ethnic minorities might be able to draw on to find employment in more deprived and ethnically dense neighbourhoods. The findings here are not clear and for some ethnic minority groups run counter to our hypotheses that ethnic penalties are lessened at higher levels of neighbourhood ethnic density and at higher levels of neighbourhood deprivation. In support of existing literature, we find no evidence of a protective effect of neighbourhood ethnic density on the employment penalties faced by working age ethnic minority groups in England. This suggests that ethnic minorities are not more able to find formal work when living in ethnically dense neighbourhoods relative to the White British group because of theorised suggestions, such as an ability to draw on ethnic minority centred social networks or because they face less racial discrimination (Clark & Drinkwater, 2002; Zwysen & Longhi, 2018). On the contrary, we find some ethnic minority groups face greater ethnic penalties when living in more ethnically dense neighbourhoods. This is the case for economic inactivity in Pakistani women and in Indian men and for unemployment in Mixed, Indian, Bangladeshi and Caribbean men and in Other ethnic group women. It could be the case that competition for similar types of employment is stronger in more ethnically dense neighbourhoods making it more difficult for ethnic minorities in certain groups to find a job.

We find working aged people in England regardless of their ethnic group are considerably more likely to be out of the labour market or unemployed and looking for work if they live in a more deprived neighbourhood. We find that the relationship between neighbourhood deprivation and labour market outcomes is not as strong for selected ethnic minority groups suggesting greater economic integration in tough labour market circumstances. This provides some support for our hypothesis that ethnic minorities face smaller ethnic penalties in more deprived neighbourhoods. However, this support is strongest in ethnic minority groups who do not have ethnic penalties in labour market outcomes measured in this paper. For example, women in the White Other group are increasingly less likely to be unemployed and economic inactive compared with the White British group when living in more deprived neighbourhoods. The same is the case for unemployment in Indian women and in African and Bangladeshi men.

Whilst this could be due to different socialisation processes in deprived neighbourhoods for these selected groups, it could also be due to some ethnic minorities being more able and willing to take up formal work in deprived neighbourhoods that is not observed in the current analysis. This could be due to the nature of the work that is accessible and available in deprived neighbourhoods and that certain ethnic minorities only move to these places because of the availability of this employment. According to 2011 Census data, ethnic minority groups are overrepresented in the accommodation and food services and the human health and social work industries, particularly in rural and coastal areas (Potter-Collins, 2014). These sectors have found it hard to recruit entry level jobs from local populations (Anderson, 2010) and therefore it could be the case ethnic minority people face less competition for employment than they might in less deprived neighbourhoods.

There was evidence for Pakistani women counter to our hypothesis that ethnic minority groups face smaller employment penalties when living in more deprived neighbourhoods. The difference in economic inactivity rates between Pakistani women and White British women were considerably larger for those living in more deprived neighbourhoods. This finding suggests whatever explains poor labour market engagement amongst Pakistani women is worse in deprived neighbourhoods. It could be due to greater employment discrimination (whether perceived or realised) in more deprived neighbourhoods, or due to the type of deprived neighbourhoods where Pakistani women are more concentrated. (Astell-Burt et al., 2012; Bécares et al., 2009; Zhang et al., 2017). Pakistani women living in England are concentrated in towns and cities in the North and Midlands which are still recovering economically from deindustrialisation and face higher levels of unemployment compared with other parts of the country (Beatty & Fothergill, 2020). It could be the case that traditional family roles described above that make it

difficult to enter employment are harder to overcome in these places because it is harder for anyone, regardless of ethnicity and sex, to find a job. Further investigation of Pakistani women's lower level of engagement with the labour market and its interplay with neighbourhood deprivation and neighbourhood ethnic density is required.

Assuming policy interventions to improve employment outcomes rely on finite resources and finite political will, it would make sense to target improving labour market outcomes of those living in the most deprived neighbourhoods. This is because all people, regardless of ethnic group, are more likely to be out of work in deprived neighbourhoods. Neighbourhood employment disadvantage has previously been addressed by initiatives such as the Working Neighbourhoods Fund which was specifically tasked in part with tackling worklessness by ethnicity (Crisp et al., 2009; DCLG, 2015b). One way this could be achieved is by encouraging and enabling the use of formal childcare in deprived neighbourhoods by increasing the availability of services and ensuring there is sufficient quality and affordability (Crisp et al., 2009). This could benefit groups, such as Pakistani women, who might be restricted from entering the labour market due to childcare responsibilities. The current government's levelling up agenda has a potential to reignite these sorts of policy initiatives (HM Treasury, 2021). Planning these interventions, however, should take into account the academic literature that suggests recent area-based initiatives to improve employment outcomes have demonstrated little or no effect (Kearns & Mason, 2018).

If achieving equality of employment outcomes by ethnic group is a policy aim, interventions should target most ethnic minority groups who face ethnic employment penalties wherever they live. For example, Bangladeshi women and Indian women who are not in the labour market and Caribbean men and African men who are in the labour market but without work. There are simple and politically neutral interventions that could seek to achieve ethnic group equality in employment. One example is an implementation of recommendations of the McGregor-Smith Race in the workplace review which suggested, among other things, medium and large listed businesses and public bodies should published breakdowns of employees by race and pay band (Clark & Shankley, 2020). Publication of this sort of data should also be extended to recruitment processes where it is collected. Moreover, employment law could require recruitment of employees by all employers to remove names and addresses from applicants before they are shortlisted for interviews (Adamovic, 2022). Requirements for all large employers to provide training to employees on unconscious bias especially for those involved in recruitment might also bring about positive change (Derous & Ryan, 2019). It should be noted that unconscious bias training initiatives are in their infancy and existing evidence on their effectiveness suggests they are doing little more than demonstrating organisations are taking action to tackle biases (Noon, 2017). These and other interventions ought to be trialled using experimental research methods to see which is most effective in reducing ethnic penalties in employment.

There are limitations with the current paper to consider. The UKHLS sample attrition is worst amongst the ethnic minority boost sample and among ethnic minorities in the general population sample. These respondents are critical for the type of analysis in this paper and their selective attrition is likely to bias the results. Other predictors of attrition between baseline and follow-up were being born overseas, being younger and having lower educational qualifications. It is not clear how the attrition may bias the results on the extent to which neighbourhood ethnic density and neighbourhood employment deprivation differentially operate over ethnic groups. Imputation of the missing respondents who dropped out of the survey might have reduced this bias however multiple imputation models by chained equations using the variables in a wide data format would not converge due to their high level of collinearity.

The ethnic groups used in this analysis, while more detailed than those used in previous research on this topic, contain substantial heterogeneity in terms of the concept of ethnicity. For example, the Mixed group contain those whose parents could be from a combination of all the other ethnic groups used in the analysis. The same criticism could be levelled to some extent at all the other categories, but especially the White Other and Other ethnic groups. Analysis using more detailed groups is problematic because of the sample size. Another limitation, as with most observational quantitative research, is omitted variable bias. There are almost certainly factors that explain why certain ethnic minority groups face greater ethnic penalties in deprived neighbourhoods and ethnically dense neighbourhoods. These could be explored more formally using causal analysis methods such as marginal structural modelling.

There are strengths of this paper that enable us to overcome several limitations of previous research, including an overreliance on cross-sectional data and a neglect of the independence of neighbourhood deprivation and ethnic density in terms of their association with labour market outcomes and an analysis of detailed ethnic groups. Sensitivity analysis bridges a gap to previous literature where slightly different approaches have been implemented, for example, those which have measured ethnic diversity rather than co-ethnic density and measured deprivation at the spatial scale of local labour markets rather than at neighbourhood level. Our sensitivity analysis suggests the use of measures of coethnic and ethnic diversity are largely interchangeable in terms of the broad substantive findings and analysis at the scale of Travel to Work Areas does not alter the substantive findings either.

In summary, this paper, using nationally representative longitudinal data, evidences labour market ethnic penalties for selected ethnic minority groups in both women and men. There is little support that these are lessened in more deprived neighbourhoods or in more ethnically dense neighbourhoods for those groups with the greatest ethnic penalties. On the contrary, some ethnic minority groups are more likely to face ethnic employment penalties in more deprived or more ethnically dense neighbourhoods. We suggest that policies to improve labour market outcomes in England should target all people

in the most deprived neighbourhoods and target ethnic minorities wherever they live.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in UKDS at https://beta.ukdataservice.ac.uk/datacatalogue/studies/study?id=7248, reference number 7248.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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