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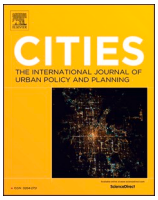

Spatial concentration of gambling opportunities: An urban scale perspective

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ABSTRACT

Critics allege that there is a worrying proliferation of gambling opportunities in the UK. Unfortunately, most studies on the proliferation of gambling opportunities focus on regional patterns. This study employs city-wide analyses to investigate linkages between neighbourhood deprivation and gambling provisioning in urban centres by carrying out comparative analyses of locational patterns of gambling establishments with grocery retailers. Results reveal significant variations at city and intra-urban levels of analysis compared to national/regional studies. This study found a higher likelihood of gambling establishments in ethnic minority, underprivileged and student neighbourhoods. In conclusion, this study recommends that approaches to tackle the proliferation of gambling should be tailored to reflect observed local patterns rather than 'one-size fits all' policies.

1. Introduction

The proliferation of gambling opportunities has been investigated across multiple disciplines due to associations with damaging health concerns, continuing decline of traditional retail centres and deprivation, which are all important issues within the urban context. Over time gambling establishments have come to be seen as toxic retail uses with serious negative consequences (Adeniyi et al., 2023; Macdonald et al., 2018; Townshend, 2017). This led to policy changes in the UK, involving reducing the maximum stake on fixed odds betting terminals from £100 to £2 in 2019 (Gambling Commission, 2021). Despite this, there remains a need to understand associations between gambling and neighbourhoods to support the development of effective and efficient urban policies in the UK.

Numerous international studies have investigated the spatial provisioning of gambling establishments, both at regional and urban levels, and found greater provisioning in deprived communities (Gilliland & Ross, 2005; McMillen & Doran, 2006; Pearce et al., 2008). More importantly, literatures further allege that the abundant provisioning of gambling establishments does not only disproportionately characterise urban communities but shows evidence of deliberate targeting of these communities (Macdonald et al., 2018; Portas, 2011). However, in the UK, the major peer-reviewed studies (Adeniyi et al., 2020b; Wardle et al., 2014) that have carried out robust empirical analyses on the concentration of gambling services in disadvantaged neighbourhoods have only focused on regional and national patterns, a shortcoming this study seeks to address.

Geographical studies clearly demonstrate the need for local analysis and emphasise the importance of scale in unearthing important insights into geographic phenomena (Anselin, 1995; Fotheringham & Brunsdon, 1999). For instance, spatial structure and processes vary over space in complex and localised ways, but national and regional studies produce results that are representative of average patterns, making their results of very limited use for local level policy formation (Fotheringham and Brunsdon, 1999). This study argues that there is the possibility that regional/national approaches might mask local variations, failing to reveal subtle but important differences that local scale analyses would unearth. Hence, there is dearth of robust empirical studies at city levels in the UK, which is critically important because policy formation to address the scourge of proliferating gambling opportunities needs to be driven by city and local level analysis, not least as these are the levels at which policies are implemented.

Therefore, the major question this study seeks to answer is: "is the pattern of high concentration within deprived and vulnerable communities of gambling establishments unearthed at national and regional levels in the UK replicated at city wide or intra-urban levels?" Answering this will be facilitated by comparative analysis of location preferences of gambling establishments with another retail type, using establishments

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deemed widely acceptable with ubiquitous demand as a comparator (i.e., supermarkets and food and grocery retailers (FGRs hereafter). FGRs are used as comparator because they have a relatively consistent presence regardless of socio-economic composition in the UK (Maguire et al., 2015).

As such, this study adopts a 2-case study approach by comparing gambling and FGR retail provisioning. A case study investigation is particularly appropriate when in depth understanding of a phenomenon is required (Yin, 2014; Crowe et al., 2011). A 2-case study approach is particularly important due to the complexities in the location preferences of gambling type establishments. By adopting a comparative analysis using 2 case studies, this research provides an in-depth, multi-faceted and objective investigation of each case study entity (i.e., gambling and FGRs) to enable a nuanced examination of access and service provisioning in relation to socio-economic disadvantage, a major contribution of this research.

Accordingly, this study undertakes a critical comparative assessment of the location preferences of gambling establishments (betting shops, casino, bingo halls and family entertainment centres and amusement parks that offer gambling services) and FGRs across three cities in England. This will assist in disentangling the local and contextual factors impacting gambling location preferences. By so doing, this study will not only add to the growing body of literature on location preferences of retail trades but also provide valuable contributions to the debate surrounding alleged targeting of disadvantaged consumers by gambling establishments.

2. Literature Review

2.1. Spatial patterns of gambling provisioning

The consequences of participating in gambling have been well documented (Orford, 2010; Wardle et al., 2019) and are not only manifest on participants but have far wider reaching consequences (Atherton & Beynon, 2019). This has led to several empirical studies investigating increased opportunities to participate in gambling as a result of geographical access.

There is also evidence from empirical studies both internationally and within the UK suggesting that gambling opportunities are highly prevalent in deprived communities. In North America, there is strong evidence linking availability of gambling opportunities to deprived urban communities (Gilliland & Ross, 2005; Papineau et al., 2020; Robitaille & Herjean, 2008). Gilliland and Ross (2005) and Robitaille and Herjean (2008) found highest provisioning of video lottery terminals in areas with high distress levels and socio-economically disadvantaged neighbourhoods. Papineau et al. (2020) investigated connections between underprivileged environments, access to gambling and gambling vulnerability in three Quebec cities, finding that disadvantaged neighbourhoods were on average over four times closer to a gambling outlet compared to more advantaged areas, confirming evidence of high availability in urban deprived neighbourhoods.

In Australia and New Zealand, exposure to gambling has also received widespread attention. Marshall and Baker (2002) alluded that over time, the spatial patterns of gaming machines increasingly corresponded with socio-economic patterns, with prevalence in deprived localities in Melbourne and Sydney. Rintoul et al. (2013) further analysed how socio-economic disadvantage impacted gamblers' losses on electronic gaming machines in suburban areas in Melbourne. Analysis identified high levels of gambling availability in disadvantaged neighbourhoods which contributed to high financial losses within these neighbourhoods compared to their less disadvantaged counterparts. Similarly in New Zealand, socially disadvantaged neighbourhoods have the densest gaming provisioning. Travel distance analysis revealed that residents of advantaged neighbourhoods travelled two times farther to gambling venues compared to disadvantaged communities (Pearce et al., 2008).

National level studies in Denmark and Finland have also focused on the relationship between electronic gambling machines (EGMs) and socio-economic deprivation (Kristiansen & Lund, 2022; Raisamo et al., 2019). In Denmark, Kristiansen and Lund (2022) uncovered high clustering of EGMs across major cities. Authors further allege that population density does not adequately explain the observed patterns. More importantly, the study uncovered a socio-economic divide with high prevalence of EGMs in low socio-economic status neighbourhoods. Likewise in Finland, gambling provisioning follows similar patterns (Raisamo et al., 2019). The study uncovered a negative correlation between neighbourhood median income and EGM patterns. Interestingly, population density had no impact on EGM provision. This is particularly interesting considering that gambling is operated by a state-owned company. Another study in Spain (Pérez et al., 2022) at city level unravelled similar patterns with disadvantaged urban neighbourhoods having higher prevalence of gambling provisioning in Madrid.

In the UK, earlier studies focused on the side effects of participating in gambling (Orford, 2010). Only more recently have studies focused on locational characteristics of gambling establishments. There is evidence of a strong socio-economic gradient in provisioning in the UK. Wardle et al. (2014) discovered a concentration of fixed odds betting terminals in historical centres, new and seaside towns in the UK. Macdonald et al. (2018) examined the spatial patterning of retailers selling "potentially health-damaging services/services (p.1)" including gambling establishments, alcohol, and fast-food outlets. The study uncovered a co-location tendency among these potentially damaging retailers, especially in deprived neighbourhood across Scotland. A more recent study (Adeniyi et al., 2020b) examined the alleged systematic concentration of gambling provisioning across England. The study found markedly denser and more concentrated presence of gambling retailers in deprived commercial localities in England. Unfortunately, that study was at national level, reiterating the need for local analysis in the UK.

2.2. Spatial patterns of FGR provisioning

Interest in food retailing and socio-economic deprivation developed from different contextual issues, especially dietary concerns and the notion of food deserts described as inner cities with low availability of nutritious and cheap food where residents depend on higher priced food from corner shops (Laurence, 1997). This led to serious debate on health and dietary concerns and availability of choices both internationally and in the UK (Lee & Lim, 2009; Black et al., 2012; Thibodeaux, 2016; Hamidi, 2020).

In the US, recent studies identified a systematic absence of supermarket and grocery retailers in lower income, disadvantaged and ethnic minority communities, especially African American communities (Hamidi, 2020; Lamichhane et al., 2013; Li & Ashuri, 2018; Thibodeaux, 2016). However, in Canada there appears little justification for the notion of food deserts as several studies found better access to supermarket and grocers in inner cities and deprived localities (Lu & Qiu, 2015; Luan et al., 2016). Although these studies found evidence of under provisioning in some low-income neighbourhoods, they concluded that deprived neighbourhoods were better provided for compared to affluent neighbourhoods.

Meanwhile, in the UK, the results of studies are mixed. Some studies identified food deserts with poor provisioning in deprived communities (Burgoine et al., 2017; Clarke et al., 2002), yet others concluded that deprived neighbourhoods have better provisioning compared to their affluent counterparts (Macdonald et al., 2009; Smith et al., 2010). In addition, other empirical studies concluded that food provisioning was similar across the spectrum of deprivation, with both deprived and affluent communities having statistically similar patterns of grocery and food provisioning (Maguire et al., 2015).

There are several limitations to these studies on food provisioning. Firstly, some of the studies examined different food retail types, but within a single location (Burgoine et al., 2017; Lamichhane et al., 2013;

Maguire et al., 2015). Hence, it is possible that results of their studies are peculiar to the city of study and might not be observed across other cities. Additionally, Bao and Tong (2017) argued that the contrasting results might be due to the different spatial scales the studies have adopted, making it difficult to compare their results.

2.3. Theoretical considerations

Different theoretical underpinnings have been adopted to explain retail location at macro, city wide and micro scale perspectives such as central place theory (Christaller, 1966) and spatial interaction models (Nakaya et al., 2007). Unfortunately, these theoretical models have very limited relevance to this study - especially the classical model which assumes that all consumers are equal - as this research seeks to understand if gambling retailers are concentrated in deprived neighbourhoods in the UK. However, the principle of minimum differentiation which highlights the importance of agglomeration of similar retail trades because of the complementary benefits it offers (Brown, 1993; Pascal & McCall, 1980), might hold some of the explanations of the observed gambling provisioning.

Undoubtedly, the observed locations of gambling and casino-type establishments are entrenched in complexities that might be explained by demand and supply side factors, patterns of socio-economic characteristics, consumer behaviour, policies and regulations that have over time impacted on centrality, the prevailing characteristics of the built environment and different marketing strategies adopted over the years. This research understands that it will be very difficult to disentangle the effects of their marketing strategies on observed realities, which justifies the methodological underpinnings to carry out a comparative analysis of gambling retailers and FGRs.

2.4. Limitations of studies on spatial patterns of gambling and rationale for this study

A number of these studies did not take account of the underlying population within their study areas (Macdonald et al., 2018; Pearce et al., 2008) so there could be under or over estimation of gambling provisioning, since highly populated urban areas could have a greater presence of retailers but also be areas of high deprivation. More importantly, most of these studies carried out a one-sided analysis to infer targeting of customers, whereas, only a comparison with more conventional retailers will help to understand better the notion of deliberate targeting.

In the UK, although Adeniyi et al. (2020b) compared location preferences of gambling and grocery establishments to find greater concentrations in vulnerable communities, as the study focused on regional/national patterns the results were complex and multifaceted. The study established that at national level, gambling retailers are more concentrated in deprived communities, but it remains unclear if this association is also true at local levels and across different cities. Hence, the results failed to provide clear explanation if England-wide relationships will also be evident at intra-city levels and across different cities.

Additionally, national, or global analyses which generalise across all regions might be misleading at local levels, especially if there are large spatial variations in the phenomena of study (Fotheringham & Brunsdon, 1999). As such, policies and solutions implemented from regional or national level analyses might not always adequately address key local issues across all communities (Wise, 2017). Interestingly, studies on food retailing and socio-economically disadvantaged neighbourhoods in the UK have been investigated majorly at city-wide and intra urban levels (Clarke et al., 2002: Maguire et al., 2015) while the studies on gambling in the UK (Adeniyi et al., 2020b; Wardle et al., 2014) have focused on national only level analyses.

As seen from the review of literature, there are international studies on gambling provisioning both at national and urban levels. Notably, in the UK, studies are mostly at national level. Given this lack of empirical studies of gambling provisioning at a city-wide scale in the UK, compared to international studies, there is a need for local analysis to unravel whether the concentration of gambling establishments is similarly evident across city-wide and intra urban analyses. Hence, this study seeks to carry out a comparative analysis using not only similar spatial scales, but also similar provisioning measures to identify the similarities and differences in the location preferences of FGRs and gambling establishments. By so doing we investigate if the concentration and alleged targeting of deprived communities at national and regional levels are replicated at city-wide level, using multiple cities. More importantly, this aligns the research on gambling provisioning in the UK to other international studies.

3. Study area

Three cities in England were selected for this study. Selection of cities for the study involved three considerations. First, the cities selected must have a strong economic base and be part of the UK Core City Group (Core Cities, 2006), which are the major commercial hubs in England. Second, the cities should reflect regional variations (i.e., North, Midlands and South) for representativeness. Third, they need to reflect both affluent and deprived area characteristics. Accordingly, Leeds, Nottingham[1] and Bristol were selected. Bristol was selected in the South because it is the only southern city within the Core City Group, a relatively affluent city with a strong economic base. Nottingham was selected because of its central location (Midlands) and being one of the most deprived cities in the UK. Leeds is regarded as the third best retail city in the UK and is categorised among the top five cities in England for wealth creation (Core Cities, 2017).

4. Methods

4.1. Data, sources, and analytical procedures

Gambling outlets, food outlets and floorspace and socio-economic characteristics were obtained from UK Gambling Commission Register, April 2015 and Geolytix version 7, April 2016 respectively. The gambling outlet register contains the addresses of all registered outlets of betting shops, bingo halls, casino, and family entertainment centres. FGR outlet data includes all addresses, co-ordinates, postcodes and floorspaces sizes of grocery outlets (supermarkets, independents, and multiples) in the UK. All addresses in Leeds, Nottingham and Bristol were extracted from both datasets. Data on socio-economic characteristics including, housing tenure, ethnic minority composition, occupational status, income, family composition, age composition and educational qualification were collected from UK Census 2011 (Nomis, 2011) (see Table 1). In addition, the Index of Multiple Deprivation and geographical boundaries were obtained from Department of Communities and Local Government (2015) and Digimap (2017). At the time of carrying out this research, these were the most recent data sources available.

For this study particular analytical techniques were adopted to disentangle the complex city-wide relationships between gambling establishments and area deprivation. The analytical steps are listed below.

[1] Findings from Nottingham City were not comparable against Leeds and Bristol. Careful analysis identified that 90 % of the 182 LSOAs in Nottingham are within the most deprived deciles (1–3) of the IMD. This skewness towards deprivation can be attributed to the tightly drawn borders of Nottingham City due to the non-inclusion of its affluent suburb such as West Bridgford and Beeston (Nottingham City Council, 2018; Punter, 2009). A decision was made to include its affluent suburb Broxtowe and Rushcliffe in the analysis. Hence, Nottingham refers to all the neighbourhoods within Nottingham, Rushcliffe and Broxtowe for this study.

Table 1
All variables considered, literature evidence with justification for selection or rejection, with selected variables in bold.

Literature evidence	Variable	Reason for selection/ rejection
Smoyer-Tomic et al., 2008	Owner Occupiers	Rejected– Even though it displays is shows strong association with retail locations, it has strong negative correlation with no car households.
	Social Renters	Rejected. – Show correlation with AASRs in one city. Also dropped because another housing tenure variable already selected.
	Private Renters	**Selected – Shows strong correlation with retail locations and also represents housing tenure in the classification.**
Gilliland & Ross, 2005; Smoyer-Tomic et al., 2008;	Couple Family	Rejected- Shows high negative correlation with households with no car and does not really add much to the context of this study.
	Lone Parent Family	Rejected – No correlation with retail locations across the 3 areas.
Wheeler et al., 2006; Li & Ashuri, 2018; Smoyer-Tomic et al., 2008;	Indian/Pakistan/ Bangladeshi	Rejected – No correlation with retail locations across the 3 areas.
Gilliland & Ross, 2005; Thibodeaux, 2016;	British Chinese	Rejected – Although shows correlation with concerned retail provisioning, adds little to the classification because it has very low variations. Inclusion also created a cluster with <2 % of total LSOAs.
	Blacks	**Selected – Has strong association with both group of retailers. Very important ethnic minority in relation to socio-economic deprivation in the UK.**
Robitaille & Herjean, 2008; Smoyer-Tomic et al., 2008; Wardle et al., 2014; Lu & Qiu, 2015	Person aged 18–24	Rejected - No new information added to the classification (Replaced with full time students 18 over).
	Person aged 25–44	Rejected - Not adding new information to the classification.
	Person aged 45–64	Rejected – Low standard deviation and not adding any relevant information to the classification.
	Person aged 65+	Rejected - Old and economically in-active population with low variation across the study area.
	No qualifications	**Selected – Strong evidence from literature review.**
Robitaille & Herjean, 2008; Burgoine et al., 2017	Level 1 Qualifications	Rejected – Low spread across the study areas and did not add any new information to the classification.
	Level 2 Qualifications	Rejected - Low variance across study areas.
Robitaille & Herjean, 2008; Black et al., 2012; Pickernell et al., 2013; Lu & Qiu, 2015; Smoyer-Tomic et al., 2008; Clarke et al., 2002; Burgoine et al., 2017	**No Car Households**	**Selected – A proxy for low income with very strong evidence from review of literature.**
Gilliland & Ross, 2005	**Fulltime Students**	**Selected – very good variation across the study areas (used to replace rejected persons aged 18–24).**
	Managers and Professional	**Selected – Shows association with gambling and FGR locations. Variable is a good indicator of affluence and strong positive association with level 4 qualification.**
	Intermediate Occupations	Rejected – Dropped for managers and professionals as it has no new information to add to the classification.
	Routine Occupation	Rejected - No relationship with retail provision in this study and high correlation with persons with no academic qualifications.
	Never Worked/ Long Term Unemployed	**Selected – Important occupational classification variable with strong evidence from literature review.**

Step 1: Developing a multivariate neighbourhood classification to measure underlying deprivation characteristics, using UK 2011 Census data.

Step 2: Validating the neighbourhood classification created in step 1 by comparing it to IMD 2015 to confirm conformity with established realities.

Step 3: Hotspot estimation using kernel density estimation (KDE; (Silverman, 1986)) to detect clustering of gambling outlets and FGR floorspace and to compare those patterns to the neighbourhood classification.

Step 4: Identification of local clustering or spatial outliers of FGR and gambling provisioning using the local indicator of spatial association (LISA) and relating these to the neighbourhood classification.

Step 5: Statistical analysis of gambling and FGR provisioning in relation to derived neighbourhood categories by analysing and comparing mean differences between categories. Likewise, modelling assessed the effect of each neighbourhood category on the presence or absence of either FGR or gambling establishments. Omega squared (ω2) and Cohens D were used to calculate the effect size (Field, 2018; Stevens, 2012).

4.2. *Measuring outlets' provisioning*

To measure gambling provisioning, a count of all gambling outlets was undertaken. Therefore, addresses and postcodes of all gambling locations (except for gambling services in pubs and restaurants) within Leeds, Nottingham and Bristol were linked to lower super output area (LSOA) level using the geo-convert look up table (GeoConvert, n.d.).

For FGRs, the data from Geolytix categorised floorspace for each food retailer into 4 bands, namely (a) <3013 ft^2; (b) 3013 to 15,069 ft^2; (c) 15,069 to 30,138 ft^2; and (d) 30,138 ft^2+. Bands "a". "b" and "c" were converted into a continuous variable type by averaging the upper and lower band while 30,138ft^2 was adopted for band "d" as it had no upper limit. In addition, both floorspace and outlets were adopted for the FGR analysis in line with literature on measures of food provisioning (Clarke et al., 2002). All counts of gambling and grocery outlets and floorspace sizes were weighted with numbers of households per LSOA. Thereafter, each LSOA with its respective retail provisioning was linked

to the population-weighted centroids provided by the Office for National Statistics (Office for National Statistics (ONS), 2011) which provides geographical coordinates for all LSOAs.

4.3. Step 1 – creating an area socio-economic classification

4.3.1. Neighbourhood socio-economic characteristics

To measure area characteristics, this study moved beyond using the Index of Multiple Deprivation, contrary to previous UK studies (Adeniyi et al., 2020b; Wardle et al., 2014). Instead, neighbourhood disadvantage was measured using the principles of geodemographics (Harris et al., 2007) using the UK 2011 national Census Data (Table 1). The justification for developing an area classification is that it is constructed from socio-economic characteristics which have been specifically identified from literature to be drivers of demand for gambling and FGR locations. Furthermore, the existing UK neighbourhood classification (Vickers & Rees, 2007) is multipurpose and might not appropriately address the needs of this research. This is because this research seeks to investigate how different socio-economic characteristics impact and shape location of gambling outlets at local levels.

4.3.2. Neighbourhood classification

For the neighbourhood classification, K-means method was adopted. All seven steps described by Milligan (1996) were executed on all the variables selected in Leeds, Nottingham, and Bristol to determine the final variables for the classification. Table 1 also shows the variables considered for classification and the justification for their rejection or selection. Variables with high collinearity were interchanged based on their relationship with FGRs and gambling provisioning. *Z*-score standardisation was adopted to ensure no variable dominated the classification. To select the total number of clusters, numbers of clusters from 2 to 7 were executed and each carefully examined to evaluate its applicability and conformity to the context of this research. Finally, a 4-cluster classification was selected after careful considerations. The bar charts in Fig. 1 show the final classification across the 3 cities and the distribution of the seven selected variables. It also shows the cluster characteristics and name of each cluster. Clusters are named based on their most dominant characteristics although in no way suggesting that the clusters are only constituted of the named variable(s). The name of the clusters are ethnic (cluster1), student (cluster 2), affluent (cluster 3) and socially underprivilege (cluster 4) clusters.

4.4. Step 2 – validating the area classification (neighbourhood clusters)

This section validates the four-cluster neighbourhood classification against the IMD 2015 to confirm if the classification is optimal and assigns the different LSOAs in line with underlying deprivation patterns. All LSOAs in the ethnic cluster are in deciles 1–3 (IMD Decile 1 – most deprived 10 % LSOAs and 10 – least deprived 10 % LSOAs) across the three cities. These deciles represent the most deprived LSOAs. Student cluster is mixed and cut across the least and most deprived LSOAs. The affluent neighbourhoods across the three cities have highest representation in the least deprived deciles. Lastly, socially underprivileged cluster has the highest presence in the two most deprived deciles in Leeds, Nottingham, and Bristol. Overall, the variables selected to create the area classification broadly reflect prevailing socio-economic environments regarding deprivation in the selected cities. Not only that, these variables were previously identified as related to gambling preferences, making them particularly applicable to the context of this study (see supplementary information).

4.5. Step 3 – comparison of Kernel Density Estimation (KDE) maps for gambling and FGR floorspace and area classification

The maps in Fig. 2, show the results of the KDE for the two groups of retailers and geographical patterns of the different neighbourhoods in Leeds and Bristol (Fig. 2 shows maps of Leeds and Bristol. Visual comparison of FGR floorspace (Fig. 2a) and gambling provision (Fig. 2b) in Leeds shows some similarities with high presence in student, ethnic and socially underprivileged neighbourhoods (Fig. 2c). Irrespective of these similarities, a very pronounced difference is the high clustering seen in floorspace provisioning which cuts across all neighbourhoods in the centre of Leeds and its periphery, including affluent neighbourhoods. Contrastingly, hotspots of gambling establishments are mostly in the student, ethnic and socially underprivileged neighbourhoods of Leeds.

Fig. 2d–f show hotspot maps for floorspace provisioning, gambling, and area classification respectively in Bristol. Fig. 2d and f show high floorspace provisioning across all neighbourhood characteristics in the west, showing a relatively even pattern. From Fig. 2e, high clustering of gambling establishments can be seen in similar areas to FGRs (Fig. 2d). However, there is a more noticeable presence of gambling hotspots (Fig. 2e) in the ethnic and socially underprivileged clusters in the centre, south and west. Therefore, in Bristol, although there is clustering of gambling retailers in student, ethnic and socially underprivileged clusters, similar to FGRs, gambling retailers still have their highest incidence in deprived neighbourhoods.

Finally, Fig. 3 (a–c) shows the KDE maps for FGR floorspace, gambling density and neighbourhood classifications in Nottingham. Fig. 3a shows high food provisioning around the centre and its periphery classified as student, affluent, ethnic, and socially underprivileged neighbourhoods (Fig. 3c), similar to gambling provisioning (Fig. 3b). In contrast, there are some ethnic neighbourhoods that have low incidence of food provisioning but high clustering of gambling opportunities. Also, there are deprived and affluent areas which have high incidence of both gambling and FGRs. On the other hand, gambling hotspots seems to be more clustered around the city centre and its periphery, mostly classified as ethic, student and socially underprivilege compared to FGRs.

4.6. Step 4 – identify specific neighbourhoods with local clustering or spatial outliers of FGR floorspaces and gambling provisioning across the different neighbourhood classification

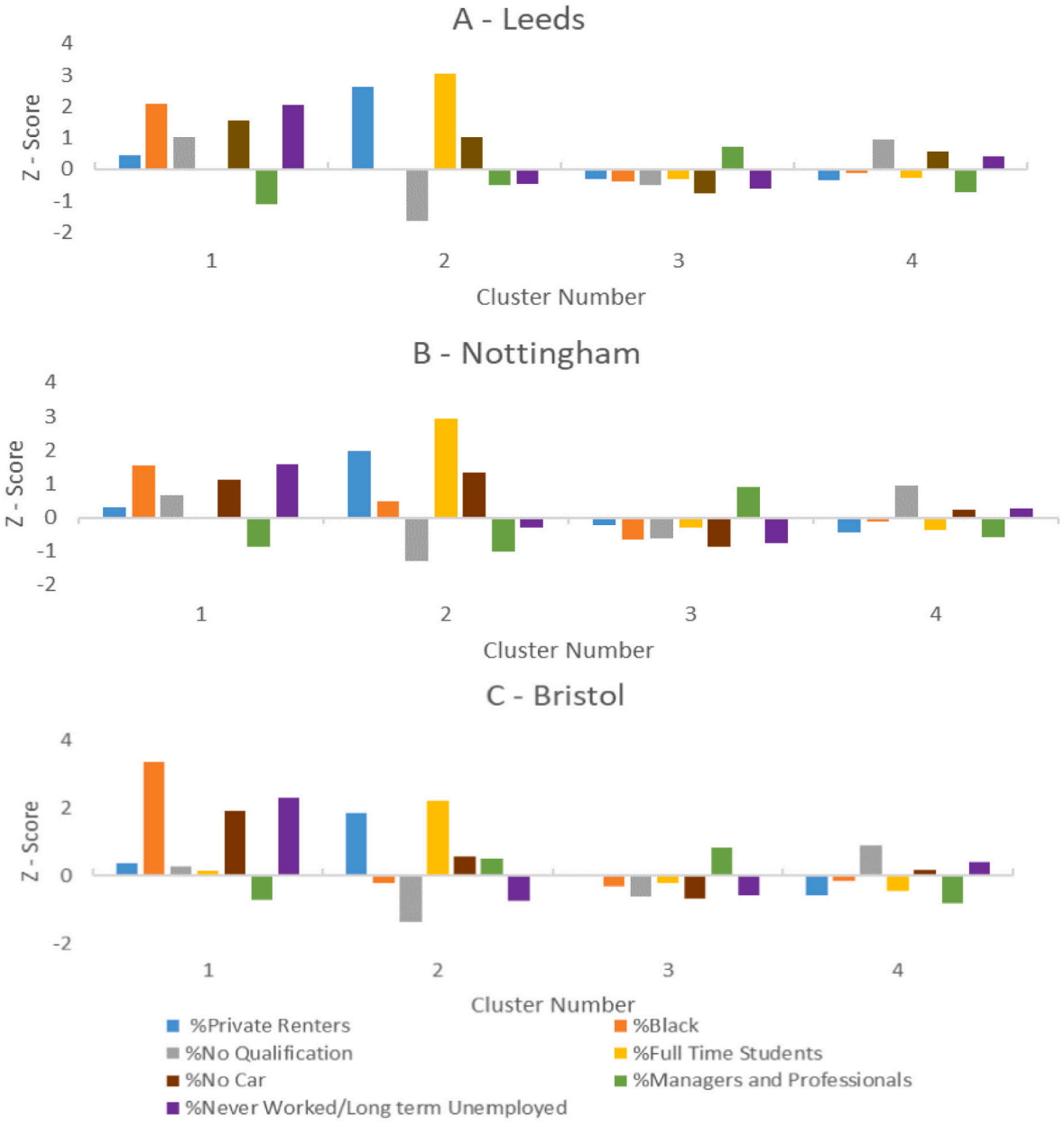
LISA is a technique used to identify spatial outliers and local clusters of an occurrence (Anselin, 1995). Table 2 shows the result of the LISA for both retail groups in the cities across the different neighbourhoods. Gambling establishments have higher presence (HL) within socially underprivileged neighbourhoods compared to FGRs especially in Leeds and Bristol. Therefore, within disadvantaged neighbourhoods highly characterised by low educational attainment and poor mobility, concentrated gambling provision is prevalent.

4.7. Step 5 statistical analysis of gambling, FGR provisioning and neighbourhood characteristics in Leeds, Nottingham, and Bristol

4.7.1. Analysis of the mean differences using one way ANOVA

Table 3 shows descriptive statistics and one way ANOVA results for gambling, FGR provision and neighbourhood classes in the three cities. Descriptive statistics revealed some interesting patterns. One major similarity is that the student neighbourhoods have the highest means across all the groups of retailers and cities. The Welch F test in Table 3 shows significant difference in the means of gambling provisioning ($p < .05$) across the neighbourhoods with large size effect, while the opposite is the case for FGR provisioning in Leeds ($p > .05$). In Bristol, FGR outlets and overall gambling provisioning significantly differ across the neighbourhoods ($p < .05$) also with medium effect size. Interestingly, in all cities, FGR floorspace shows similar patterns across all neighbourhoods ($p > .05$), showing a relatively consistent pattern regardless of socio-economic characteristics. In Nottingham, no significant differences in FGRs and gambling provisioning is observed ($p > .05$), suggesting a sound justification for comparison with gambling retailers.

Games Howell multiple comparison test was carried out to ascertain significantly different neighbourhood means. In Leeds, the mean of



Cluster	Cities			Dominant Characteristics	Given Name
	Leeds	Nottingham	Bristol		
	Number Percentage of LSOA				
1	56(*11.6%*)	60(*18.7%*)	16(*6.1%*)	Blacks, No Car Households and Never worked/Long-term Unemployed Persons.	Ethnic Cluster
2	37(*7.7%*)	27(*8.4%*)	31(*11.8%*)	Fulltime Students, Private Renters and No Car Households.	Student Cluster
3	254(*52.7%*)	144(*44.9%*)	103(*39.2%*)	Managers and Professionals.	Affluent Cluster
4	135(*28.7%*)	90(*28%*)	113(*43%*)	No qualifications, No Car and Never worked/Long-term Unemployed.	Socially underprivileged Cluster
Total	**482(*100%*)**	**321(*100%*)**	**263(*100%*)**		

Fig. 1. Neighbourhood classification, cluster composition and cluster names in the selected 3 cities.

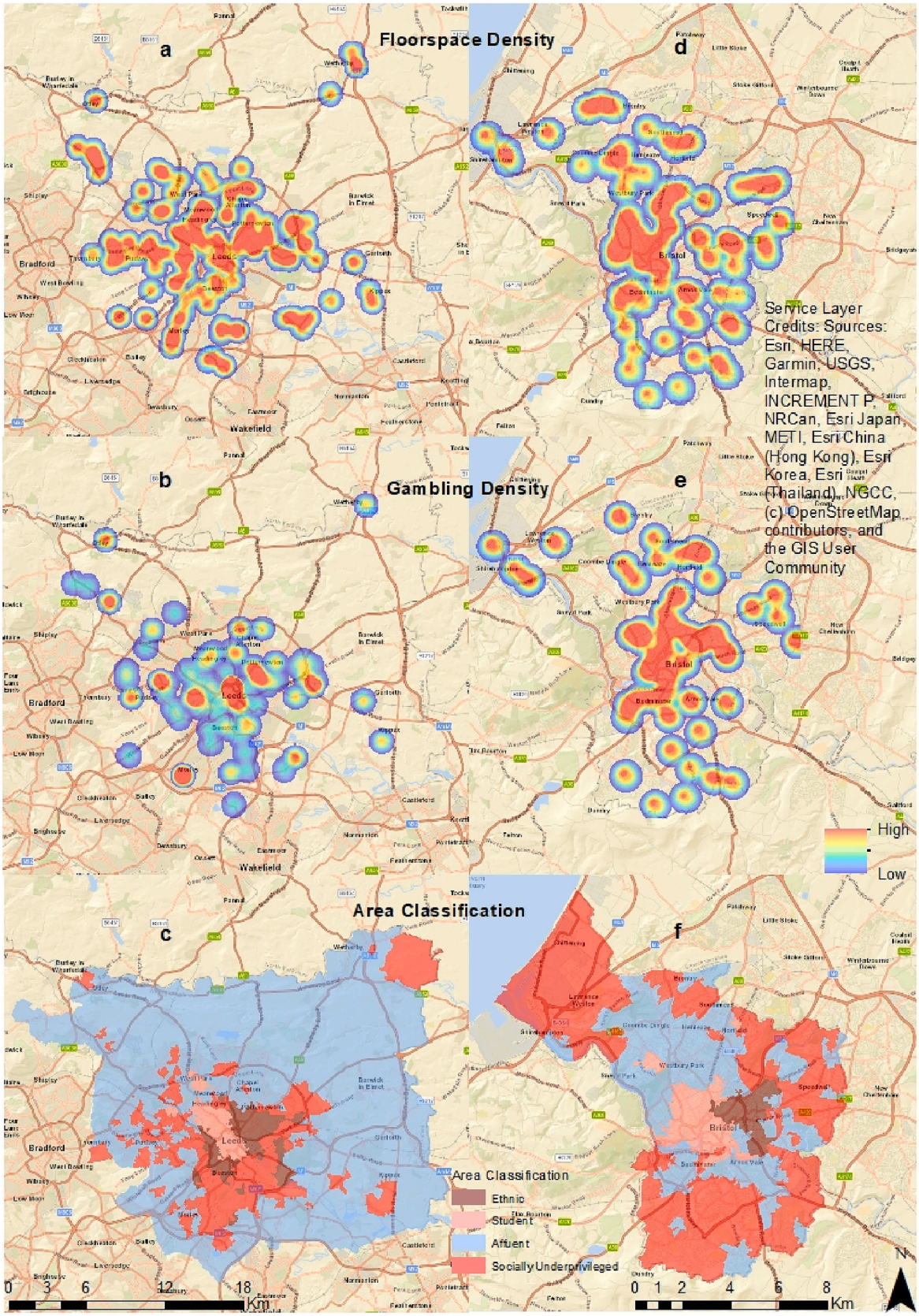


Fig. 2. Hotspot maps for FGRs, gambling retailers and area classification maps for Leeds (2a–c respectively) and Bristol (2d–f respectively).

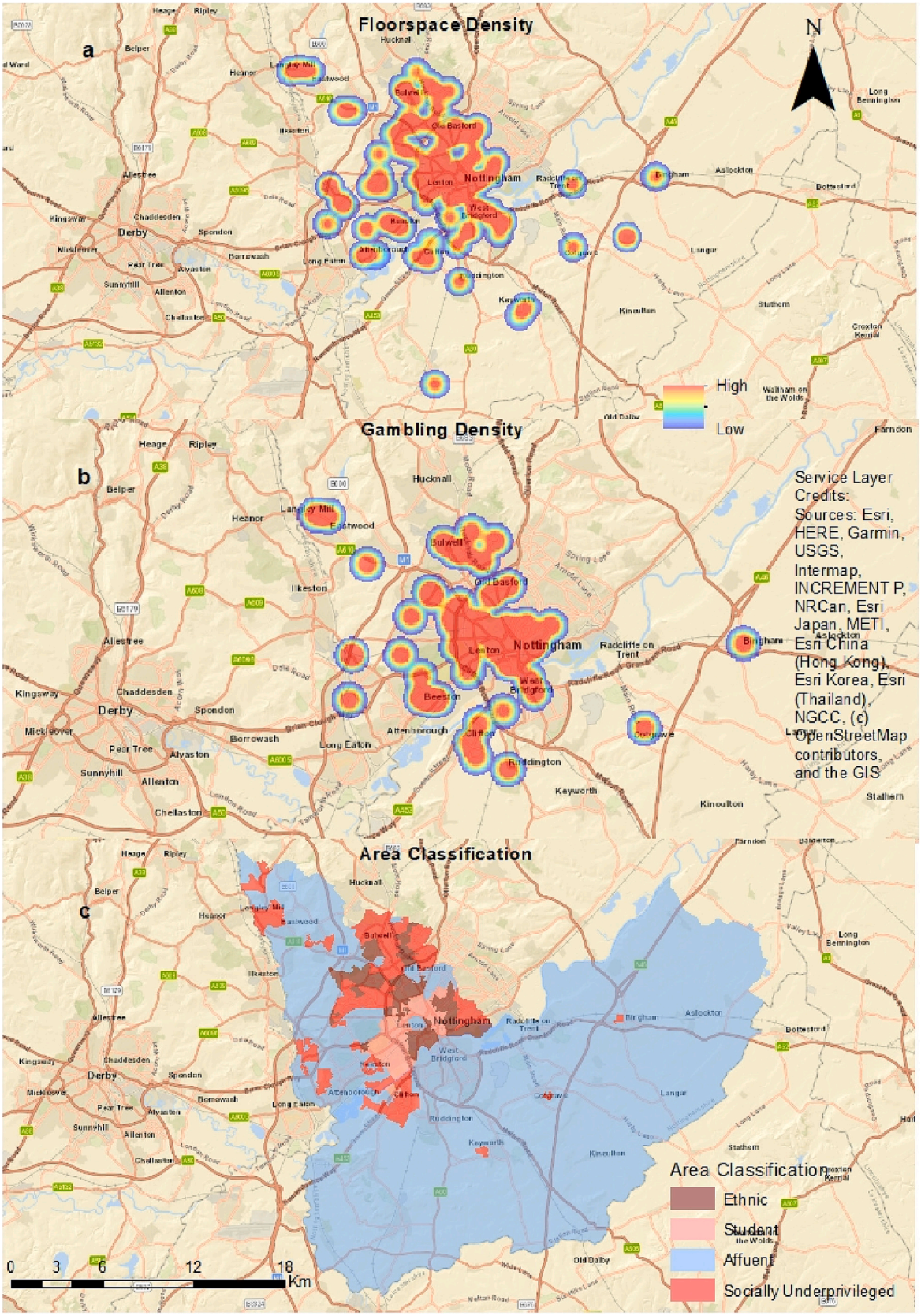


Fig. 3. Hotspot maps for FGR floorspace density (4a), gambling outlets density (4b) and area classification map (4c) in Nottingham.

Table 2
LSOA across the different neighbourhood classifications with significant clustering of FGR floorspace and gambling establishment based on LISA analysis ($p < .05$).

	Cluster classification							
	Ethnic		Student		Affluent		Soc. Underprivileged	
	F/space (%)	All gambling (%)	F/space (%)	All gambling (%)	F/space (%)	All gambling (%)	F/space (%)	All gambling (%)
Leeds								
HH	1.79	0.00	5.41	8.11	0.39	0.00	0.00	0.74
HL	3.57	5.36	0.00	2.70	1.97	5.12	3.70	7.41
LH	7.14	10.71	10.81	8.11	4.33	4.33	5.93	5.19
Nottingham								
HH	3.33	1.67	11.11	3.70	0.88	0.00	1.11	1.11
HL	6.67	1.67	3.70	0.00	7.02	6.14	6.67	3.33
LH	5.00	5.00	22.22	11.11	0.88	2.63	3.33	5.56
Bristol								
HH	0.00	0.00	0.00	25.81	0.00	0.97	0.00	0.88
HL	0.00	0.00	0.00	0.00	2.91	2.91	3.54	10.62
LH	12.50	0.00	6.45	3.23	5.83	5.83	2.65	1.77

F/space = Food and grocery retail floorspace.
HH = High High cluster - LSOAs with high clustering with areas around them also having high clustering.
HL = High Low spatial outliers - areas with high clustering, but their neighbours have low presence of retailers, signifying outliers.
LH = Low High spatial outliers - LSOAs with low presence of retailers, but their neighbours have high retail presence, signifying outliers.

gambling retailers in the socially underprivileged neighbourhoods is significantly higher compared to the affluent neighbourhoods ($p = .03$, $d^2 = 0.31$), whereas the means of FGRs floorspace are statistically similar across all neighbourhoods ($p > .05$). Similarly, in Bristol the student neighbourhoods have a significantly higher mean of gambling outlets compared to FGR floorspaces in affluent neighbourhoods ($p = .046$, $d = 0.65$) with medium effect size. In addition, the means of overall gambling outlets and FGR outlets are significantly higher in student neighbourhoods compared to ethnic neighbourhoods ($p = .048$, $d = 0.75$, $p = .013$, $d = 0.84$) with medium effect sizes. Accordingly, there is a markedly higher concentration of gambling retailers in neighbourhoods with deprived characteristics and high inequality compared to affluent neighbourhoods. Furthermore, gambling establishments are also concentrated in deprived and highly disadvantaged neighbourhoods in contrast to FGR floorspace. Therefore, deprivation characteristics across neighbourhoods have strong linkages with gambling provisioning especially in Leeds and Bristol.

4.7.2. Modelling the effect of neighbourhood characteristics on FGR and gambling provisioning using Binary Logistic Regression (BLR)

This section investigated the effects of neighbourhood characteristics on the presence or absence of gambling and FGRs using a BLR. To achieve this, the LSOAs with a presence of FGRs are assigned 1 and those without any are assigned 0. Gambling outlets were also recoded similarly. For the BLR, the affluent classification is used as the reference group. In Leeds, overall, gambling and casino outlets are more than twice as likely to be in ethnic and socially underprivileged areas ($OR = 2.9$, $p < .01$ and $OR = 2.4$, $p < .01$ respectively) compared to the affluent neighbourhoods. Whereas there is no higher likelihood of FGRs across all the neighbourhoods ($OR = 1.11$, 1.51, 1.54 and $p > .05$).

In Nottingham, the likelihood of overall gambling and FGRs is higher in student neighbourhoods compared to affluent neighbourhoods ($OR = 3.62$ and $OR = 2.4$, $p < .05$), but the prevalence of gambling in deprived areas compared to grocery provisioning is higher as shown by the ORs above. The situation is similar in Bristol with overall gambling and FGR provisioning having over four times ($OR = 4.2$, $p < .001$) and 3 times ($OR = 2.72$, $p < .05$) likelihood in student neighbourhoods compared to affluent neighbourhoods. Therefore, across the three cities there is a higher concentration of gambling establishments in deprived neighbourhoods and areas with high inequality compared to the more proportionally distributed grocery provisioning.

5. Discussion and conclusion

Empirical analyses have shown a concentration of gambling opportunities in deprived localities across England (Wardle et al., 2014). Additionally, there is evidence to suggest targeting of deprived localities by gambling businesses (Adeniyi et al., 2020b). However, all these investigations were at national levels. This study argues that analysis at lower scale across multiple cities can help to further unravel the complexities identified in the national studies (Fotheringham & Brunsdon, 1999). More importantly, the results will inform local policy formation which would help address the worsening impact of inequalities across British cities (Wardle et al., 2019).

This study adopted a 5-step analytical procedure to disentangle relationships between gambling and socio-economic deprivation from an urban scale perspective. Firstly, this study developed an area classification to measure area deprivation using socio-economic data that are strong determinants of retail gambling locations from literature through the principles of geodemographics (Harris et al., 2007). That custom-built measure classified neighbourhoods into ethnic, student, affluent and socially underprivileged classes. Validation revealed that the measure appropriately depicts the neighbourhood characteristic in Leeds, Nottingham, and Bristol. Not only that, as the classification is rooted in consumer lifestyle patterns, it also provides insights relevant to retail location preferences.

The results of the KDE show interesting patterns across the three cities, with high concentration of both floorspace and gambling provisioning in student LSOAs which are mostly deprived neighbourhoods in Leeds and Nottingham and some mixed characteristics (both affluent and deprived) in Bristol. This highlights some very important similarities in the location of these retailers, comparable to national/regional studies that have found abundant provisioning of food retailers (McDonald et al., 2009) and gambling in deprived localities (Pickernell et al., 2013: Wardle et al., 2014). These retailers are strategically located in or close to the centres of these cities with good accessibility, footfall and population mix which might be a pull factor generating these observed high concentrations.

Yet key differences emerge from the KDE analyses. Hotspots of gambling retailers are in the ethnic, student and socially underprivileged neighbourhoods, which contrasts with FGR floorspace

[2] d is Cohen's D – effect size.

Table 3
Descriptive statistics and one-way ANOVA for FGRs and gambling outlets across the 4 neighbourhoods in Leeds, Nottingham, and Bristol.

	Count of outlets/floorspace					Outlets/floorspace per '000 households											
	N class.	FGRs	FGR floorspace	Gambling	All gambling	FGR floorspace			FGR			Gambling			All gambling		
						Mean	SD	Sig	Mean	SD	Sig	Mean	SD	Sig	Mean	SD	*Sig*
Leeds	1	14	12,355,905	17	18	325,231.29	836,361.44	0.233 (0.002)	0.37	0.77	0.111 (0.006)	0.49	1.16	0.018 (0.015)	0.51	1.17	0.013 (0.016)
	2	32	17,176,405	39	46	707,986.80	2,546,712.89		1.32	3.65		1.53	7.37		1.8	8.08	
	3	71	68,560,730	37	37	356,232.92	1,169,748.05		0.39	0.9		0.2	0.71		0.2	0.71	
	4	56	59,520,615	55	55	638,402.05	1,587,230.78		0.61	1.19		0.55	1.41		0.55	1.41	
	Total	**173**	**157,613,655**	**148**	**156**	**458,663.70**	**1,417,188.57**		**0.52**	**1.39**		**0.43**	**2.27**		**0.46**	**2.46**	
Nottingham	1	20	20,342,310	22	22	490,654.78	1,415,261.78	0.834 (0.000)	0.49	1.47	0.363 (0.001)	0.56	2.05	0.198 (0.005)	0.56	2.05	192 (0.006)
	2	18	9,944,305	17	21	624,996.95	1,402,847.02		1.02	1.38		0.98	2.93		1.21	3.33	
	3	53	43,094,710	25	27	399,265.11	1,010,299.50		0.52	1.06		0.23	0.78		0.25	0.81	
	4	34	29,985,710	29	29	475,728.36	1,431,223.36		0.55	1.17		0.46	1.25		0.46	1.25	
	Total	**125**	**103,367,035**	**93**	**99**	**456,772.37**	**1,248,689.87**		**0.57**	**1.21**		**0.42**	**1.49**		**0.45**	**1.58**	
Bristol	1	3	2,712,300	4	4	173,926.67	489,208.25	0.3 (0.003)	0.19	0.54	**0.016 (0.029)**	0.25	0.45	0.078 (015)	0.25	0.45	0.041 (0.02)
	2	29	14,614,905	26	29	618,958.69	1,361,814.70		1.21	1.61		1.01	1.65		1.16	1.77	
	3	36	26,519,410	19	19	394,906.28	973,113.09		0.53	0.96		0.27	0.73		0.27	0.73	
	4	37	33,300,905	33	33	419,409.85	1,271,712.79		0.47	0.96		0.43	1.19		0.43	1.19	
	Total	**105**	**77,147,520**	**82**	**85**	**418,400.02**	**1,137,842.17**		**0.56**	**1.06**		**0.42**	**1.09**		**0.44**	**1.12**	
	Overall	**403**	**338,128,210**	**323**	**340**	**448,160.45**	**1,301,685.96**		**0.55**	**1.26**		**0.43**	**1.82**		**0.45**	**1.94**	

Sig = p value and effect size i.e., *omega -squared in parenthesis ().*
NClasss. = Neighbourhood classification 1 = ethnic, 2 = student, 3 = affluent and 4 = socially underprivileged.
Gambling includes betting shops and bingo halls.
All gambling – Total gambling provision including betting shops, bingo halls, amusement centres, family entertainment centres and casinos.
Omega-Squared - 0.01 ≤ v/small; 0.01–0.05 = small; 0.06–0.14 = medium; >0.14 = large.

provisioning where affluent neighbourhoods also show more noticeable hotspots across the 3 cities. The tendency for high concentration is further reinforced by the results of the LISA across the 3 cities, with gambling establishments having high clustering and spatial outliers across the highly deprived neighbourhoods compared to FGRs. This further amplifies the results of previous UK and International studies that found evidence of not only concentration of gambling provisioning in deprived neighbourhoods (Kristiansen & Lund, 2022; Macdonald et al., 2018; Raisamo et al., 2019; Wardle et al., 2014), but also systematic and deliberate concentration of gambling provisioning in England (Adeniyi et al., 2020a, 2020b; Macdonald et al., 2018; Portas, 2011).

To further disentangle the location patterns of gambling retailers in relation to FGR floorspace provisioning, a one-way ANOVA shows significant differences in the means for gambling outlets across the different neighbourhoods. Multiple comparison tests further show gambling provisioning is higher in the neighbourhoods with deprived and mixed characteristics compared to the areas with affluent characteristics in Leeds and Bristol. This result is in line with international studies at national levels that found evidence of targeting of vulnerable and at-risk population by gambling establishments (Wheeler et al., 2006; Tan et al., 2010)). On the other hand, Nottingham shows no significant evidence of deprivation effects on gambling provisioning, contrary to earlier identified national-wide studies which attributed an overall concentration in of gambling establishments in vulnerable and deprived areas (Pearce et al., 2008; Wardle et al., 2014). This emphasises the rationale for this study, which is to go a level deeper than national and regional analysis to disentangle the seemingly complex patterns identified by previous literatures, in the expectation of finding more subtle and nuanced local variations. These results confirm the need for further unravelling of the complexity identified in previous UK studies (Adeniyi, et al., 2020b; Wardle et al., 2014).

This study further investigated how the different neighbourhood characteristics impact on the presence or absence of gambling retailing. The results show broadly similar patterns across the three cities with higher likelihood of gambling outlets in underprivileged and mixed neighbourhoods compared to affluent areas. Contrastingly, only neighbourhoods with mixed characteristics have a higher prevalence of food retailers compared to affluent areas in Nottingham and Bristol, whereas in Leeds, no significant evidence emerged of higher prevalence of FGRs. This highlights both similarities and differences in location patterns of these retailers and further differentiates the subtly different drivers of gambling and food location. Clearly, more deprived communities are thriving neighbourhoods for gambling and casino establishments. In addition, communities with mixed characteristics which exhibit high inequalities around city centres and their peripheries are favourable grounds for all businesses examined in this study, most especially gambling establishments, reflecting their advantages of good accessibility and transport infrastructure together with high local demand and availability of premises which act as key factors to make them suitable locations for diverse retail types.

6. Contributions

This study contributes to better understanding of retail locations, socio-economic deprivation, and interactions between them. By carrying out analysis of gambling provision at urban levels in the UK, this paper aligns the UK understanding with other international studies, a major contribution of this study.

From the findings, the locations of both FGRs and gambling retailers reflect a series of factors, with neighbourhood socio-economic characteristics playing a very important role. However, most retail location theories fail to highlight or incorporate this important driver of retail location strategies. Given that most classical theories of retail location start from a flawed assumption that all consumers are similar, there is therefore a need to further seek ways to integrate socio-economic dimensions. This might be achieved by further refinement of spatial interaction-type models to incorporate neighbourhood socio-economic dimensions.

In line with the principle of minimum differentiation, this research further highlights the impact of agglomeration and co-location which can be seen with similar retail outlets clustering together to drive business performance, most especially gambling outlets. This might suggest that gambling establishments who are seeking to access attractive markets and neighbourhoods are also competing among themselves as results show that these retailers are concentrated in similar, often deprived, areas.

This study therefore has serious implications for policy formation. The results further extend studies that examine regional patterns of gambling and grocery retail locations and socio-economic deprivation. It provides a very clear picture of the notion of the location preferences of gambling and grocery retailers at micro level. Across the three cities, there is strong evidence of dense concentrations of gambling retailers in deprived neighbourhoods in Leeds, Nottingham, and Bristol, whereas the situation is different for grocery retailers, with similar levels of provisioning across affluent and most underprivileged communities. This clearly supports allegations of targeting of underprivileged neighbourhoods by gambling retailers across the cities and provides a clear picture compared to results of regional type studies.

In 2015, there was an amendment to the Use Classes Order which saw betting offices become ‘sui generis’ (a class on its own) thereby requiring a planning application to change any premise to this use, yet even if permission is refused in an area with multiple of such outlets, the planning authority faces the threat of a very expensive appeal (Murray, 2023). However, Jones et al. (2021) concluded that “the change to planning legislation seemingly designed to control the concentration and proliferation of betting shops on high streets, has, to date, been largely ineffective and seems unlikely to assuage a number of critics' concerns about social deprivation, anti-social behaviour and the viability and vitality of high streets.” (p. 4).

The wider issues from critics around decline in traditional shopping areas and high streets include considerable concerns about concentrations of betting shops (Portas, 2011; Townshend, 2017), and that policy has not positively impacted the glaring concentration in deprived neighbourhoods. Indeed, in Parliamentary discussions in 2016, an MP moved a motion for an amendment to the Neighbourhood Planning Bill to deal with guidance on clustering of betting shops, but the then Housing and Planning Minister said that he did not see a need for national guidance (Woodhouse & Grimwood, 2020). In summary, in several respects there seems both limited scope for action or political commitment towards localised controls over betting shop concentrations in the UK.

Furthermore, the clustering (or targeting) is particularly pronounced in Leeds compared to the other two cities, showing that irrespective of similarities, there are subtle differences across cities. In recognition of this, there is justification for tailored policies at a city-wide level rather than adopting a general ‘one-size fits all’ policy. Therefore, legislation that reinstates some form of control related to local levels of demand, making over-provision a basis for rejection of an application needs to be put in place. This would help to reduce the cumulative negative effects of their agglomeration in vulnerable localities.

6.1. Limitations and future research

A limitation of this research is the modifiable areal unit problem (MAUP) which refers to bias introduced as a result of generalisation (Nelson & Brewer, 2017). The MAUP is a bias introduced because of aggregating data to different scales and areal units. The different geo-analyses carried out in this study may be affected by MAUP. To reduce the effect of MAUP, the lowest geographical scale is usually recommended (Tuson et al., 2019). Hence, this study used the lowest spatial scale with available datasets. In addition, this study did not

incorporate catchment area dynamics into the analysis (Singleton et al., 2016) due to the comparative nature of the study. Hence, future research could develop methods that would allow for the introduction of catchment area dynamics and still allow for comparability, which would enhance the robustness of the results. Further, future studies could also compare casino and gambling to other establishments in the service industry as against food retailers as this might reveal further insights.

In addition, although our analysis on grocers used floorspace as a measure of provisioning, there are other measures of provisioning which this study did not consider. For instance, literature on food deserts identifies that even though there might seem to be abundant provisioning of food floorspace/outlet provisioning in deprived neighbourhoods, number of retail brands (choices) and quality of products offered also matters (Bao & Tong, 2017; Black et al., 2012; Adeniyi et al., 2020b). Unfortunately, our study did not include brand which introduces some limitation in our result in relation to food provisioning. Therefore, future studies on food provisioning can explore this gap in this research. Irrespective of this limitation, the study has been able to provide some critical understanding on the notion of deliberate targeting of disadvantaged community by gambling establishments.

Another limitation to this study is the data used for the research. The study utilised UK Census 2011, gambling premises data for 2015 and FGR location data for 2016. This is due to unavailability of data for the same period for all the datasets used, especially the UK Census data which is only available every 10 years. Moreover, these were the most recent data as at the time of carrying out this research. Therefore, future studies can employ more recent data across similar time points to further extend the results of this study. Overall, this study has shown the convolutedness and complexities of retail location decisions at micro-levels. It demonstrates the need for rigorous and detailed analysis to fully decipher the crux of the controversial issues surrounding the location preferences of gambling retailers and the need to protect vulnerable communities and reduce inequalities between deprived and affluent neighbourhoods.

CRediT authorship contribution statement

Oluwole Adeniyi – Conceptualisation, literature review, methodology, data curation, original draft preparation, visualisation, validation, analysis.

Abraham Brown – Conceptualisation, eviewing and editing, supervision, validation.

Paul Whysall – Conceptualisation, reviewing and editing, supervision, validation.

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Declaration of competing interest

The authors declare no conflict of interest.

Data availability

The authors do not have permission to share data.

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Appendix A. Supplementary data

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