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The geography of gambling: A socio-spatial analysis of gambling machine location and area-level socio-economic status

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Abstract

This study mapped the geographical location and density of electronic gambling machines (EGMs) in Denmark and investigated whether gambling machines cluster in areas with specific socio-economic status (SES) characteristics. Using micro-area modeling and inverse probability weighted regression adjustments, the study was based on register data on SES, EGM location data and geographical grid data. Findings showed that EGMs were distributed throughout the country with some notable clusters in the larger cities. While identifying city-based hotspots, findings also indicated that pure population density offered merely partial explanations in term of EGM location. In terms of links between area-level SES and EGM density, the study found a significant and positive correlation between low level of SES and EGM density. This study could inform fine grained geographical risk localization and harm minimizing measures that transcends well-known administrative area classifications.

Keywords: EGM, Location, risk localisation, micro-area modelling

Introduction

Because of liberalization and deregulation of gambling markets in many countries, opportunities to gamble have increased, and so has the number of regular gamblers and individuals experiencing gambling problems (Abbott, 2017a; Griffiths et al., 2009). The global prevalence of problem gambling ranges between 0.1–5.8% in the adult population with greater prevalence in regions with greater gambling availability (Calado & Griffiths, 2016). In Denmark, the most recent gambling prevalence study among the adult population found that 3.2% had experienced gambling problems within the last 12 months, that 2.6% were at-risk gamblers, and that 0.3% were pathological gamblers (Fridberg & Birkelund, 2016). The parallel increase of gambling availability and gambling related problems has formed the basis for the so-called availability hypothesis suggesting that a positive relationship functions between gambling opportunities, gambling participation, and proportion of problem gamblers in a population (Abbot, 2017b; Hansen & Rossow, 2012; Orford, 2005; St.-Pierre et al., 2014). In this regard, the geo-spatial distribution of gambling opportunities is critical, as it determines the average proximity to gambling opportunities (Productivity Commission, 1999).

In gambling research, a number of studies have focused on individual behavior and individual level factors such as cognition and personality (Gordon & Reith, 2019; Reith 2007). However, in recent years, an emerging body of research has provided evidence concerning the positive correlations between physical access to gambling opportunities and gambling behavior (Lester, 1994; Pearce et al., 2008). Also, gambling related harms are unequally distributed in terms of socio-economic factors, as people with relatively low income, young males, and ethnic minorities all show higher rates of gambling related problems compared to average population rates (Orford et al., 2007; Volberg et al., 2001). Such evidence clearly indicates that gambling problems are socially and geographically patterned (Griffiths et al., 2010; Reith, 2012). This finding, in turn, has led some researchers to suggest that research on problematic gambling behavior need to conceptualize gambling within broader social, geographical and cultural frameworks including a focus on national policies and regulations of accessibility and availability of gambling opportunities (Livingstone & Adams 2011; Reith, 2012; Shaffer et al., 2004).

In exploring the geographically patterned availability of gambling opportunities, we enjoy reason to focus on electronic slot machines (EGMs), as significant positive associations do operate between gambling related problems and EGM gambling (Griffiths et al., 2010; Livingstone & Woolley 2007; Riesbeck & Paulsson, 2009). EGMs have been termed the "crack-cocaine" of gambling because of their element of perceived skill-involvement and the instant feedback of the outcome (Dowling et al., 2005). Internationally, EGMs have shown to be the fastest growing sector in the international gambling economy accounting for approximately 70% of gambling revenue (Griffiths et al., 2009). In this study, we examine and map the spatial distribution of EGMs in Denmark to provide evidence of the environmental factors that influence gambling behaviors. In other words, instead of focusing on individual level characteristics of EGM gamblers, we apply a socio-ecological approach (McLeroy et al., 1988; Xouridas, 2016) emphasizing that gambling is a "complex interplay between an individual and the broader social, physical and political environment in which they live" (Raisamo et al., 2019, p. 2). By applying such an approach, and by addressing structural factors such as the spatial distribution of gambling opportunities, this study aims to provide knowledge that may complement existing preventive and harm reduction measures.

Since 2012, the Danish gambling market has followed a license model. Thus, gambling operators who applies and obtains a license can provide gambling in Denmark. However, a state owned operator, Danske Lotteri Spil, holds a monopoly for providing lotteries. The license model involves two types of licenses: land-based gambling licenses, and online gambling licenses. Land based gambling licenses are found in two forms, casino-licenses and licenses for EGMs. Location decisions are not subject to regulation and exclusively taking by the EGM license holder. A national Danish survey using the National Opinion Research Center DSM Screen for Gambling Problems (NODS), involving 8,153 adults, showed that 77% of the respondents have gambled within the previous 12 months, and that 8% reported gambling on EGMs within the last year. (Bonke & Borregaard 2006). In a more recent Danish study, using NODS and the Problem Gambling Severity Index (Ferris & Wynne, 2001), Fridberg & Birkelund (2016) found that 4% of the adult population reported gambling on EGMs within the last year. In 2018, gross revenue from EGMs in Denmark accounted for 14% of the total national gross revenue (Danish Gambling Authority, 2018).

Context and review of literature

Although there has been an increase in gambling research with research outputs dramatically increasing from the mid-1930s, only limited research has examined how contextual or ecological factors influence problematic gambling (Welte et al., 2006).

Geographical exposure to gambling opportunities

In terms of geographical exposure to gambling, research has examined how rates of gambling participation and gambling related problems vary with distance from gambling venues. From an analysis of five American data sets on gambling behavior, problems, and attitudes (three national surveys, community statistical data, and community case studies), Gerstein and colleagues (1999) found that compared to living within a distance of 50–250 miles from a casino, living within a 50 mile distance almost doubled the risk of experiencing pathological gambling. In a similar vein, LaBrie and colleagues (2003) conducted a survey among 10,765 American college students attending 119 colleges in 2001. It was found that local gambling exposure of gambling influenced decisions to gamble, as students attending school in states with two or more legalized gambling venue were more likely to gamble. In a similar study among Canadian students at universities located near casinos (with casino slots), Adams and colleagues (2007) found that students from universities located near a casino were more likely to gamble on casino gambling machines compared to students from universities located far from a casino.

Welte and colleagues (2004) examined the effect of gambling availability on gambling engagement and gambling problems. From a survey of 2,631 American adults in combination with census data, it was concluded that living within a 10 miles range of a casino was positively related to gambling problems. In a later study using the same data survey data, Welte and colleagues (2007) found that for males aged

30 years or older, residential proximity to casinos predicted gambling problems. Another way to study geographic exposure to gambling opportunities has been to examine the voluntary help-seeking behavior in specific areas. In a study analyzing data from 6,599 of adults who self-excluded from Missouri casinos using MS MapPoint, (LaBrie et al., 2007) found higher levels of self-exclusion among residents in areas with a higher concentration of casinos. In a similar vein, and using data from different gambling outlets and a national health survey, Pearce and colleagues (2008) examined, by combining Geographical Information System (GIS) and logistic regression, associations between neighborhood accessibility to gambling outlets and individual gambling behavior in New Zealand. They found that, compared to residents living in areas with the furthest access to a gambling venue, residents living in areas with the closest access to gambling venues were more likely to gamble or to experience gambling problems. From a review of empirical evidence, LaPlante and Shaffer (2007) concluded that there are some support for the so-called exposure effect suggesting that increased levels of exposure of gambling opportunities to gambling opportunities are associated with increasing levels of gambling problems. However, the researchers also found evidence that questioned the exposure effect as certain places and people seem to adapt to the risks of gambling over time.

EGM density, socio-economic status and gambling related harms

As indicated, research has documented significant relations between gambling problems, socio-economic characteristics of geographic areas and availability of gambling machines (for an overview see Vasiliadis et al., 2013). Regarding the relationship between socio-economic status and gambling machine involvement, evidence exists that gambling machines tend to be placed in areas with relatively low socio-economic status (Delfabbro, 2002; Doughney, 2002; Marshall 1998; Rintoul et al., 2013). Using data from Australia, Livingstone (2001) has documented positive correlations between the number of electronic gambling machines and the socio-economic status level in specific geographic areas. Such findings have also been made in New Zealand. Using data on the location of gambling machines and the socio-economic characteristics of the population Wheeler and colleagues (2006) found that machines were disproportionately located in the most deprived areas of the country. In a similar vein, Marshall & Baker (2002) have shown that gambling on EGMs in Australia has more negative consequences in socially deprived communities compared to other areas. Similarly, American research (Martins et al., 2013) has concluded that the level of gambling related problems increases with the level of social deprivation in geographic areas. Recent research in this vein has been carried out in Great Britain (Wardle et al., 2012). From a mapping of all British gambling machines, a number of zones with relatively high density of slot machines were identified. Analyses showed significant relations between gambling machine density and socio-economic factors (residents in high density machine zones where relatively poorer and less economic active than residents in low-density machine zones).

Research employing GIS-techniques have questioned the notion of venue catchment areas as representing uniform measures established from customer's subjective estimations of travelling distance or from pre-defined distances. In an investigation of spatial variations of Australian EGM venue catchments, using Kernel density analysis Doran and colleagues (2007) found that these venues varied considerably. For example, some EGM venues showed highly concentrated catchment areas while others were more extensive with people travelling longer distances to visit them. Such findings indicate that EGM venue catchment areas are not uniform in geographical size and that not all customers tend to visit venues located close to their respective residences. Macdonald and colleagues (2018) used spatial cluster analysis to examine the socio-spatial patterning of a series of outlets providing potentially health-damaging services or products including gambling in Glasgow, Scotland. They identified a number of zones with a specific outlet density and linked these zones to a Scottish Deprivation index allocating each cluster an income score quintile ranging 1–5. As for gambling outlets, it was found that the most deprived quintile had the greatest number of gambling outlets while there was no outlets in the least deprived zone.

To estimate catchment areas of EGM gambling venues, recently research have begun employing gravity models/Huff models. In Doran and Young's (2010) study of the spatial distribution of gambling vulnerability, a Huff model was used in combination with GIS and advantage-disadvantage data. By comparing overlaps between EGM venue catchment areas provided by the Huff Model with georeferenced socio-economic data, a fine grained and visual illustration of EGM vulnerability hot spots was provided. In a study examining an Australian metropolitan area, Rintoul and colleagues (2013) also used this modelling to identify EGM venue catchments. This study found significant associations between gambling expenditure with both EGM accessibility and increased levels of socio-economic disadvantage, as the highest levels of EGM losses, were found in the most disadvantaged areas. In a study aiming to provide better estimates of the spatial distribution of problem gambling, Markham and colleagues (2017) have used a Huff model to allocate EGM expenditure data to small residential areas. In their micro simulation they added survey data and census and health behavioral data, they demonstrated that by combining such empirical data with geographically referenced EGM expenditure data, spatial simulations of problem gambling outcomes can be improved. Recent research from New Zealand has distributed proceeds from EGMs to the surrounding areas using inverse Huff-modelling to establish measures of EGM proceeds per capita at area level. It was found that the levels of EGM proceeds were highest in areas with the highest levels of socio-economic deprivation (Ward et al., 2020).

Summing up, growing evidence has emerged of associations between availability of gambling machines and elevated gambling problems in geographical areas with recent research using gravity-models and GIS-techniques providing visual and fine-grained understanding of these areas. Furthermore, research suggests that gambling machines tend to be placed in areas with relative low socio-economic status. However, links between EGM density and gambling related problems seem to be rather complex. In a review of gambling surveys from Australia and New Zealand by Storer and colleagues (2009), it was found that problem gambling increased with higher levels of EGM density. However, it was also observed that problem gambling decreased over time when EGM density was constant. Such findings indicate "that both access and adaptation forces are at work simultaneously" (Storer et al., 2009, p. 241). However, Storer and colleagues (2009) also found that the overall effect of adaptation was somewhat less than that of access, suggesting that although expenditure is likely to decline over time, increasing access may lead to increasing levels of problem gambling. In other words, the current evidence points to a relatively complex inter-relationship between higher levels of EGMs and gambling related problems.

In Denmark, as well as in other Scandinavian countries, the geographic distribution of EGMs (or other legalized gambling opportunities) have not yet been subject of scientific investigation. Therefore, we have only little knowledge of how potential gambling related harms are geographically and socially distributed in these jurisdictions. The current study aimed to address this gap in the research literature by generating knowledge on possible relationships between EGM density and the socio-economic characteristics in geographic areas in the context of a Scandinavian welfare state. The study had two specific but inter-related aims: (a) to map the location and density of EGMs in Denmark and (b) to examine the relationship between socio-economic status and EGM density in geographical areas.

Method

Data

Data for this study was obtained from three different sources: (1) geographical grid data from The Danish Geodata Agency, (2) data describing area-level as well as individual-level socio-economic status (SES) from Statistics Denmark, and (3) data on EGM location provided by The Danish Gambling Authority.

Geographical grid data

The georeferenced data consists of the national square grid that divides Denmark into vectors of 100 by 100 meter cells and topographical maps that contain information about buildings, roads, rivers, railroads etc. The georeferenced data were linked to the register data following the discretion criteria of Statistics Denmark requiring that data must be clustered to at least 100 in-habitants per measurable geographical unit before further linking to individual level data.

SES data

Data on socio-economic status on both individual- and area-level was obtained from Statistics Denmark for the most recent year (2019). Data used to characterize SES on both an individual level and area level consists of information about educational attainment (total months of full-time education), labor force affiliation (percentage of year unemployed), income (measured as spendable income), debt (total), private ownership of property (assets in housing with debt deducted) and job status in

ISCED-format (Ganzeboom & Treiman, 2010). Area level data were aggregated to capture overall area characteristics while pertaining the individual level data as well. Three other variables (gender, age and ethnicity) were included to control for confounding effects.

EGM location data

The Danish Gambling Authority provides a publicly available list of EGM license holders containing the addresses of machine location. In Denmark, the Gambling Law prohibits provision of public access to EGMs without a license and thus the register constitutes a complete list of all licensed EGMs in Denmark. The national total of EGMs is 31,712 machines placed at 2,499 different locations with the total number of machines at the same venue ranges from a single machine to a maximum of 221 machines at one specific location. Most of the high-density locations are casinos and the mean number of EGMs at a single venue was 12.6 while the mode was 3. In this case, casinos skew the general tendency of EGMs being placed at smaller, local bars in much smaller numbers. Since the register is separated from the main population registers provided by Statistics Denmark, it is manually updated and with no direct link to the other data sources besides municipality code and an address. EGM location addresses were matched with the national and publicly available Building and Housing Register (BBR) to match specific addresses within each municipality with exact coordinates of the venue. This reduced the number of venues to 2,404 venues and 31,475 machines. The remaining parts were located at mobile venues with no coordinates such as boats and ferries or located at a non-existing address. The latter applied for 2 venues with a total of 10 EGMs.

Measures

Area-level SES

To classify areas in terms of socio-economic characteristics we used a composite index. This index was composed of standardized measurements for average area income as a percentage of the mean income of the region, percentage of welfare recipients, percentage of unemployed individuals and percentage of the area population in managerial positions. Educational attainment was measured as an outcome to examine educational differences in different local settings but not to classify socio-economic status.

Analysis

Micro-area modelling

To capture the local neighborhood effect, this study involved an automated redistricting based on an inductive, recursive algorithm to isolate smaller, socio-economic clusters (Lund, 2018). While it is methodologically challenging to measure the ways individuals create and maintain social communities, the ways landscapes seem to facilitate this is not (Entwisle et al., 1997; Feld, 1981; Lund, 2018, 2019;

White et al., 2005). The shaping of cities, communities and housing follow principles of closeness and these entities are separated by way of physical barriers such roads, railways, rivers, lakes, forests or other objects that may not have been intended as separators but often act as ones (Feld, 1981; Lund, 2018). Using this logic, micro-areas were established by examining the ways individuals cluster in an already existing geography. The method involved two distinct steps. First, a definition of rules for overall geographical subdivision and measures to secure that a minimum number of inhabitants is located in each geographical entity. Second, clustering based on strict discretion criteria. As mentioned, using Danish register data involves specific discretion criteria when it comes to geographical clustering and requires at least 100 inhabitants per geographical unit before an actual merge between geography and individual data can be performed. A simple, programmable reduction of arguments is:

1. Apply separators on the total of the Danish geography.

2. Merge with the square grid and form borders to follow the grid.

3. Count inhabitants in newly formed areas and flag areas that has less than 100 inhabitants.

To satisfy the discretion criteria, it is important to secure at least 100 inhabitants per area before actual data can be applied to the geography. This requires further steps optimized to secure four separate criteria: (1) presence of at least one hundred inhabitants per area, (2) merge areas so that as few merges as possible takes place, (3) merge areas so that the areas are as physical small as possible, and (4) merge so that merges as close to the 100-rule is possible. These criteria were made to secure areas that are small in terms of geographical area as well as inhabitant wise. The overall advantage of this optimization is, that merge solutions can be evaluated objectively, and the most optimal version can be selected.

The overall computational problem with a recursive model is one of permutations. With 21.384 raw areas sharing an average of 5.4 boarders and evaluating four overall cost-functions. Choosing the optimal starting point was not possible since each choice of the model restarts all other merges. Doing so would result in a theoretical lowest number of calculations of septendecilliards of permutations and thus not efficient to run in either loops or recursions. To circumvent this, prioritizations were introduced in the form of percentage shared borders and a more linear form of merges. A reduced form is:

1. Flagged and unflagged areas are treated equally.

2. Percentage borders shared by flagged areas and the surrounding areas are calculated as well as:
   a. inhabitant size after merge;
   b. geographical size after merge; and
   c. a counter to keep track of number of merges

3. A gradient descent cost function that is gradually becoming higher with an increase in all values defined above.

4. Starting with areas with the highest percentage of shared borders; calculate how much the cost of the merge on inhabitant size, geographical size is by a recursive function and the number of merges that is required to reach the specific point.

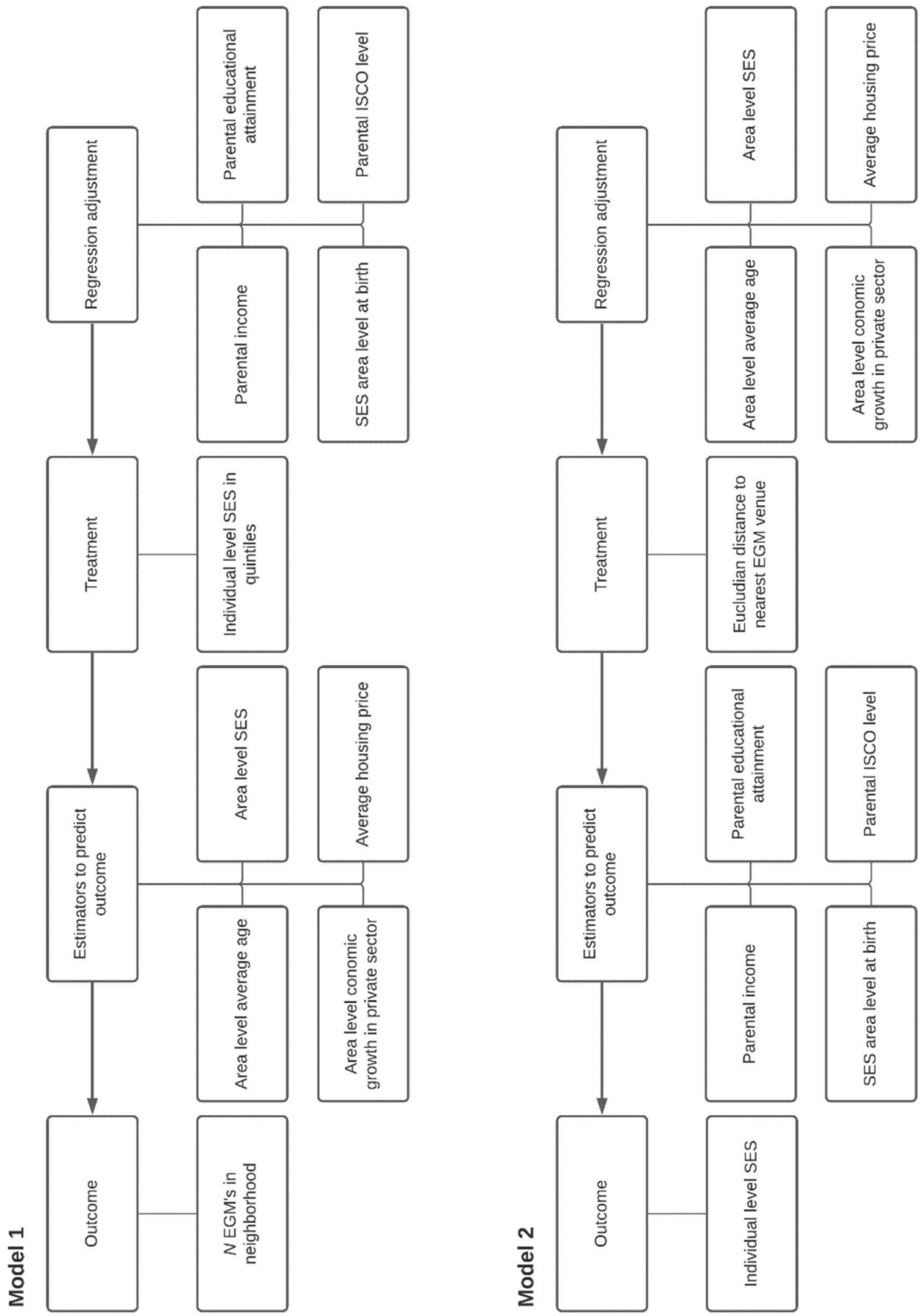
5. Recursion continues until the cost-function ceases to decrease in 10 consecutive runs.

The main advantage of this method is that it yields the same result every time and that the areas are small in terms of geographical area and number of inhabitants (Lund, 2018). Furthermore, these areas capture socio-economic homogeneity at an exceptionally high level compared to other types of area segregators such as administrative ones (Lund, 2018, 2019, 2020).

Counterfactual framework

An important factor to consider is the non-random distribution of the population geographically and that EGM placement must conceived as outcomes of specific, deliberate decisions. As mentioned, recent research has utilized gravity-models to examine spatial distributions of gambling vulnerability. In this study, we employed a different approach. While gravity-models are excellent at discerning between types of hotspots and calculating spatial distributions, they are less suited to capture the social selection occurring when comparing EGM location and SES. One potential solution would be to combine gravity-models with selection-sensitive models but since access to individual EGM turnover is restricted, this study focused on examining the social selection into different types of SES-areas and the correlation with EGM localization. Since randomized housing and EGM placement is implausible, a counterfactual framework was introduced with the use of treatment effects and inverse probability weighted regression adjustments, IPWRA, (Wooldridge, 1995, 2010). These doubly robust methods combines an outcome regression with a model for the exposure, in this case the selection, where the main concern is selection into the treatment (Wooldridge, 2010). The model thus involves four overall steps. First, an outcome, in this study either SES (Model 2 in Figure 1) or distance to nearest EGM (Model 1 in Figure 1). Second, estimators to predict the outcome separate from the treatment as individual educational attainment, income, area characteristics and age. The third step is the treatment, which involves two sub-treatments. The first treatment is based on the effect of SES measured as a composite. The second treatment is the effect of unemployment on the distance to the nearest EGM. The fourth step is the regression adjustment, where the probability of belonging to any category in the treatments listed above is calculated and adjusted for when estimating the treatment effects in the first steps of the model. In reduced form, the adjustment must contain measurements that could cause a selection into the treatments in step three. Since most of the treatments are dependent on socio-economic status, the main adjustment is through income and educational attainment with. A visualization of the analytic model is provided in Figure 1.

Figure 1
Analytic model.



As mentioned, the two treatments are individual level SES and distance to EGMs within a micro area. Both models include categorical treatment variable, which means that the treatments are modeled in a multinomial or binomial logistic regression with the form of

$$p(z,t,\gamma) = \frac{\exp(z\gamma_t)}{1 + \sum_{k=1}^{q} \exp(z\gamma_k)}$$

where $p(z,t,\gamma)$ is the conditional probability that a person receives treatment t on the condition that covariates z and γ are the parameters of the model. The inverse probability weight is applied in the form of

$$IPWE = \frac{1}{n}\sum_{i=1}^{n} Y_i \frac{1_{A_i} = a}{\widehat{p}_n(A_i = a|X_i)}$$

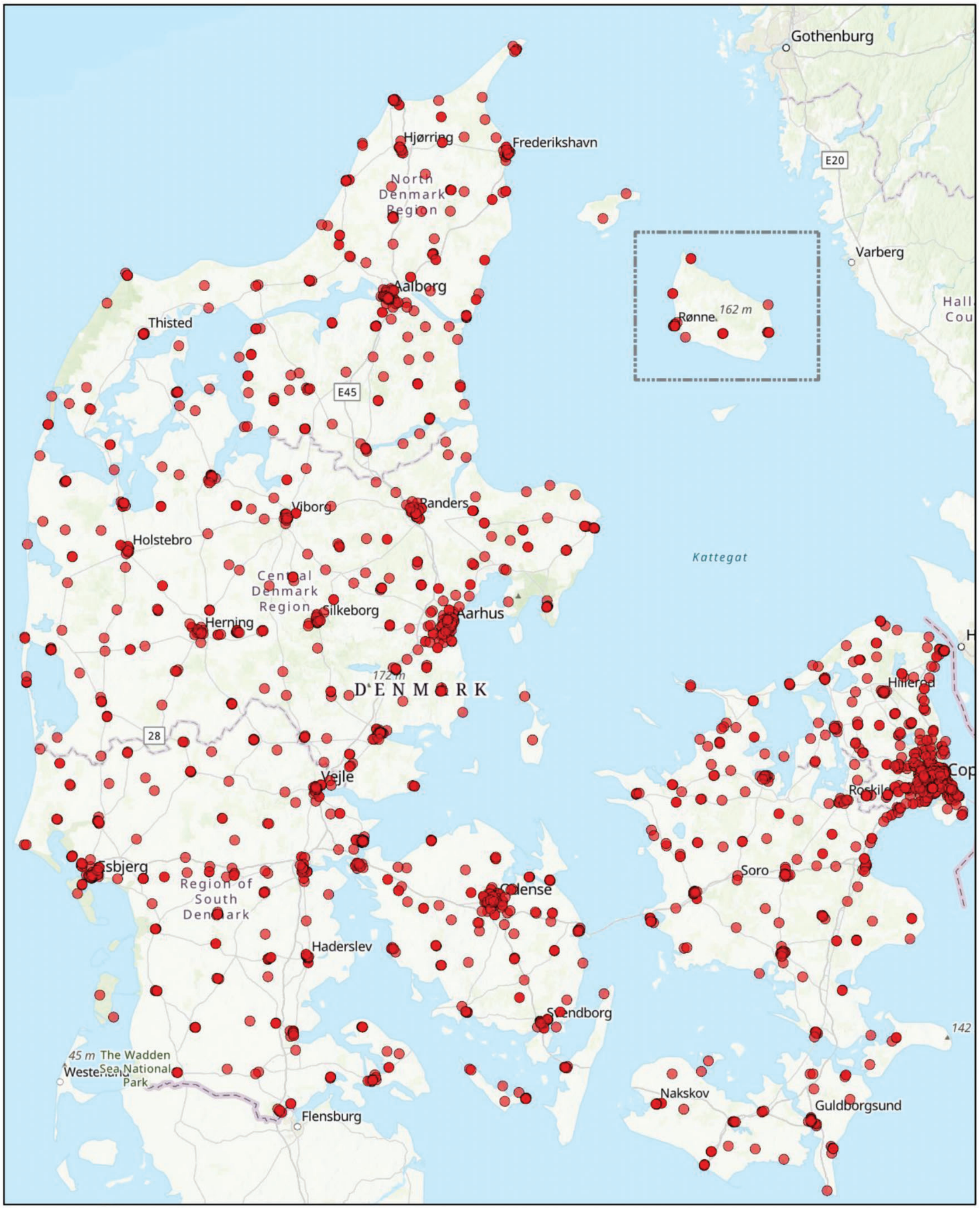
Where $\hat{p}_n$ is an estimator for the propensity for treatment, A is the possible treatments as either dichotomous or categorical variables and X_i is the value of potential covariates applied to adjust for unequal selection into the treatment.

Results

Considering the geographical distribution of EGM (see Figure 2), a few trends are clear. First, EGM venues are distributed throughout the entire country including in the more rural and less populated areas in the western part of the country. However, when it comes to concentration, a clear correlation exists between city size and number of EGMs. There are no lower limits to population density for a single or a few EGMs to be present within a geographical location but only in the most populated cities are clusters with more than one hundred EGMs present. A Moran's Index Number for global autocorrelation of .78 confirms this finding. This indicates: (a) that there is a spatial correlation between population density and number of EGM venues clustered together, and (b) that machines are present in almost every part of the country on neighborhood level. However, the Moran's index value provides no information pertaining to the actual composition of neighborhoods and how this composition correlates with clusters of EGMs. Second, the socio-economic composition of neighborhoods is related to EGM location. Specifically, aggregating data to neighborhood level and categorizing the composite neighborhood SES index into quintiles (see Table 1), allowed two observations. First, the raw number of gambling venues showed an almost linear increase where the mean number of EGMs increase as the level of area-level SES decreases indicating that even though there are clusters in high population density areas (see Figure 1), these clusters are much more present in neighborhoods with low levels of SES.

Comparing the mean number of gambling venues to the mean distance from neighborhood centroid to nearest EGM venue, the picture proved somewhat different. In this case, the distance showed linearity indicating an almost opposite trend: the lower the area-level SES, the further the distance to the nearest venue. This

Figure 2
Geographical distribution of EGM placement.



pattern applied except from neighborhoods the lowest SES level where the distance drastically inversed and became the shortest distance. Clearly, some of these distances could be biased because of different geographical distributions in the more rural areas. Furthermore, a specific problem when estimating the connection between distance and SES is that no account exists for selection bias into neighborhood

Table 1
Area-level SES and EGM measures.

Area-level SES	*N* EGM venues	$\bar{X}$ distance to nearest venue (m)
High level SES	.1208307	1352.083
2	.2227816	1550.57
3	.2404028	1797.623
4	.3668974	1809.391
Low level SES	.5261171	1286.262

Table 2
IPWRA on socioeconomic status (linear) with number of EGM venues within residential neighborhood as treatment (multinomial).

Treatment v. control	Coef. (std.err)	95% conf. interval	
1 vs 0	-.021 (.000)	.021	.023
2 vs 0	-.034 (.001)	.033	.036
3 vs 0	-.034 (.001)	.033	.037
4 vs 0	-.021 (.001)	.018	.023
5 vs 0	-.021 (.001)	.021	.023
PO mean	.124 (.000)	.123	.124

Table 3
IPWRA on Euclidian distance to nearest EGM venue (linear) with socioeconomic status as treatment (logistic).

Treatment v. control	Coef. (std.err)	95% conf. interval	
1 vs 0	-98.70 (4.21)	-106.95	-90.44
PO mean	834.07 (1.18)	831.74	836.40

deprivation. To further investigate this, we ran an IPWRA to test how individual socio-economic status was affected by the number of venues present within a given micro area (see Figure 2). Each treatment in this model compared the effect of having *n* EGMs within a neighborhood on individual level socio-economic status with the effect of no EGM within the neighborhood. Thus, the base model (0) represents a micro ares with no EGMs present and compared this to a micro area with *n* machines.

The IPWRA results indicates that the negative effect on individual level socio-economic status is present as soon as one single machine is present. There are minor differences between the treatment effect of a single machine compared to two or three but the effect appeared to be stable; as soon as an EGM is present, the individual level SES decreases. When reversing the concept and testing how individual level SES affects the mean distance to an EGM for the inhabitants in a given neighborhood, the overall effects became much more prevalent. The model, presented in Table 3, consists of a treatment where socio-economic status was divided into a dummy split at the 90th percentile so that the treatment is the lowest 10% of the socio-economic status index and the effect is measured on the mean Euclidian distance to the nearest EGM venue. While distance using street network would be preferable, these measurements becomes more unstable when having to use an aggregate neighborhood level centroid. Thus, this paper utilizes Euclidian distance to increase transparency. Even though this reverses the causality from the previous model, this model still includes control for both individual level confounders and neighborhood selection. Thus, while this model does not allow conclusions as to how neighborhood SES affect or is affected by EGM location, the effects show links between individual characteristics, neighborhood level SES and EGM location.

With the lowest 10th percentile isolated and the effect isolated to explain distance to nearest venue, it was evident that low SES decrease the mean distance to gambling machines by almost 100 meters. This means, that the bottom 10th percentile lives, on average, 100 meters closer to the nearest EGM than the rest of the population. Even though this might seem like a small difference in distance, it is worth noting that the average diameter of the neighborhoods used are 743 meters. Obviously, then individuals with low level SES have significantly shorter distance to the nearest EGM compared to the population.

Discussion

The aims of this study were to map the location of EGMs in Denmark and to examine the relationship between levels of SES and geo-spatial clustering of EGMs using statistical techniques novel to the field of the geographies of gambling. To the best of our knowledge, the current study is the first geo-spatial mapping of EGM location in Denmark and the first statistical examination of links between social deprivation and EGM density in this national context. As for the first aim, this study found that EGMs are spread throughout the country with some notable clusters in the larger cities. Even though data indicated that cities are hotspots, certain notable exceptions were determined throughout the country, indicating that city size or pure population density offers merely partial explanations in terms of EGM location. Such findings highlights the need for further studies aiming at examining area-levels variables that may be positively associated with EGM location. It has been documented by previous studies (see Welte et al., 2004) that gambling behavior may be significantly influenced by ecological factors and that the physical gambling environment may be "influencing gambling behavior at a local level" (Marshall, 2005, p. 80). On this background, it is important for future studies to examine in detail, the particular area-level factors that may influence gambling behavior.

In terms of links between socio-economic factors and EGM density, we found a significant and positive correlation between low area-level SES and EGM density. This finding is consistent with research from a number of different jurisdictions across the globe (see Livingstone, 2001; Rintoul et al., 2013; Robitaille & Herjean, 2008; Wardle et al., 2012; Wheeler et al., 2006) as well as with research on location of casinos (Conway, 2015). Specifically, we found that individuals in the lower SES percentiles lives, on average, closer to EGM venues than the rest of the population. This finding is in line with other studies (e.g. Young et al., 2012) that have examined similar issues. The concentration of EGMs in areas with relatively low socio-economic status may result in risky gambling behaviors, which in turn may lead to gambling related gambling harms (Raisamo et al., 2019) as areas with easier EGM availability may increase use and potential harms. Such risks are well established in the research literature. Research from New Zealand (Pearce et al., 2008) have found that increased availability of gambling outlets was positively correlated with gambling engagement and problem gambling. In a US study, Welte and colleagues (2006) found that living within a three minutes travel range of a gambling outlet significantly increased the likelihood of problem gambling compared to living within a travel range of ten minutes or more.

The current study has some limitations that should be taken into consideration when interpreting results. First, it may be noted, that geographic localization of EGM is not an exact measure of the actual use of the machines and thus of potential gambling harms. Therefore, to establish more valid insights regarding the actual impact of EGMs in specific areas, links to actual EGM expenditure data would have been useful. At present, however, the Danish Gambling Authority does not provide such data. Second, our design and data allows for identification of correlations while not for conclusions regarding causality even though the counterfactual framework allows for isolated effects with robustness regarding dynamic selection. In other words, this study does not allow us to conclude whether socio-economic factors impact on geographical distribution of EGMs in Denmark or vice versa. It may be hypothesized that high SES segments of the population find areas with high EGM density unattractive as residential areas leading to a decrease in housing prices, which in turn may attract individuals with low SES to such areas (Xouradis et al., 2016). However, it may also be speculated that gambling providers tend to place EGM in areas with high potential revenue, which often happens to be areas of relatively low SES status. Clearly, such causal conclusions requires time-series data and therefore longitudinal studies are needed. Similarly and related to this, future research should focus on integrating time as a factor into the model provided in this study. As pointed out by Cummings (2007, p. 355), “the challenge in understanding neighbourhood effects in epidemiology has moved on from simply describing that ‘place’ matters independently of the ‘individual’ to identifying the plausible causal pathways by which neighborhood social and material environment may affect health,” which calls for careful considerations as to how local context can be measured over time. In this vein, given exact time of EGM placement, it would be possible to investigate such potential causal relationship by testing neighborhood composition and time of EGM placement in a pseudo experimental design, allowing for isolated effects of machine placement on socio-economic trends within a given neighborhood.

Similarly, we believe that our study has some notable strengths. First, our study, by employing a counterfactual framework using inverse probability weighted regression adjustments that brings analysis close to that of a natural experiment, has advanced methods for examining geo-spatial issues in relation to EGM density and SES. Also, we believe that the micro-area modelling based on examinations of the ways people cluster in an already existing geography and thus not on given geographical boundaries (such as administrative or physical ones) may be of use in future studies focusing on dynamic geo-spatial mapping of gambling opportunities. A range of geo-spatial studies focusing on gambling availability and venue densities have examined densities within and across official administrative boundaries which carry a potential risk of the so-called modifiable areal unit problem (Macdonald et al., 2018). The model applied in this study does not rely on administrative boundaries, as it is based on a spatially weighted clustering algorithm. As such, this study address the call made by Xouradis and colleagues (2019) for the use of spatial regression models to examine local variations over different geographical areas and also to advance understanding of local relationships and spatial variations in gambling behavior. It should be observed, however, that while the suggested micro area modelling-approach holds potential in capturing social homogeneity in a wide array of phenomena, the model still relies on aggregation. Thus, although this study have provided spatial weighted clustering algorithm to examine neighborhood effects, the modifiable areal unit problem still applies.

Conclusion

In this study, we examined the geographical location and density of electronic gambling machines in Denmark focusing on whether gambling machines cluster in areas with specific socio-economic status characteristics. Our study was guided by a socio-ecological approach (McLeroy et al., 1988; Xouridas, 2016) emphasizing the complex interplay between gambling behavior and individual life-context. By applying such an approach, and by integrating (1) geographical grid data, (2) register data describing area-level as well as individual-level socio-economic status, and (3) data on EGM location, in an analytical framework involving inverse probability weighted regression adjustments, has contributed to the research literature in two aspects. First, it has advanced methods for examining geo-spatial issues in relation to EGM density and SES. Second, it has identified a significant and positive correlation between low level of SES and EGM density. The findings has implications for the prevention of gambling relating harm. The spatial analysis may provide basis for fine grained geographical risk localization that transcends well-known geographical areas based on postal number or other well-known administrative area classifications. In Denmark, the Gambling Law regulating the use and provision of EGMs obliges gambling providers to protect young people and other vulnerable groups from developing gambling related problems. In practice, this means that EGM gambling is prohibited for people below 18 years of age; that EGMs should carry a mark from the Danish Gambling Authority; and that links to the official gambling help line should be clearly visible. However, the law does not specify geographical or spatial requirements related to the placement of EGMs. From the evidence provided by this study, measures by public authorities to limit EGM density in specific areas with relatively low SES levels should be encouraged. In this regard, it should be noted that research from Australia (McMillen & Doran, 2006) that have examined the effectiveness of such area-based policies, has emphasized the need for more systematic local analysis and demonstrated the potentials of GIS-based analyses. Future area-based preventive measures, resting on a general precautionary principle (Xouradis et al., 2016) as well as improved and more fine-grained area-sensitive methods, might reduce gambling related problems and prevent potential gambling related harms.

References

Abbott, M. (2017a). *The epidemiology and impact of gambling disorder and other gambling-related harm: Discussion paper developed for the WHO Forum on Alcohol, Drugs and Addictive Behaviours, 26–28 June 2017*. Geneva, Switzerland: WHO Forum. https://www.who.int/docs/default-source/substance-use/the-epidemiology-and-impact-of-gambling-disorder-and-other-gambling-relate-harm.pdf?sfvrsn=5901c849_2

Abbott, M. (2017b). Gambling and gambling harm in New Zealand: A 28-year case study. *International Journal of Mental Health and Addiction*, *15*, 1221–1241. https://doi.org/10.1007/s11469-017-9767-6

Adams, G. R., Sullivan, A.-M., Horton, K. D., Menna, R., & Guilmette, A. M. (2007). A study of differences in Canadian university students' gambling and proximity to a casino. *Journal of Gambling Issues*, *19*, 9–17. https://doi.org/10.4309/jgi.2007.19.1

Bonke, J., & Borregaard, K. (2006). *Ludomani i Danmark. Udbredelsen af pengespil og problemspillere* [*Pathological Gambling in Denmark: The prevalence of gambling and problem gamblers*]. Copenhagen, Denmark: The National Center for Social Science Research. https://www.vive.dk/da/udgivelser/ludomani-i-danmark-3491/

Calado, F., & Griffiths, M. D. (2016). Problem gambling worldwide: An update and systematic review of empirical research (2000–2015). *Journal of Behavioral Addictions*, *5*, 592–613. https://doi.org/10.1556/2006.5.2016.073

Conway, M. (2015). Vulnerability modeling of casinos in the United States: A case study of Philadelphia. *Applied Geography*, *63*, 21–32. https://doi.org/10.1016/j.apgeog.2015.05.015

Cummings, S. (2007). Commentary: Investigating neighbourhood effects on health: Avoiding the "Local Trap." *International Journal of Epidemiology*, *36*, 355–357. https://doi.org/10.1093/ije/dym033

Danish Gambling Authority (2018). *Årsberetning 2018* [Annual Report 2018]. Copenhagen, Denmark: Author. https://www.spillemyndigheden.dk/uploads/2019-05/SPM%20%C3%85rsberetning%202018_DK.pdf

Delfabbro, P. H. (2002). *The distribution of electronic gaming machines (EGMs) and gambling related harm in metropolitan Adelaide. In:Inquiry into management of gaming machine numbers:Report Commissioned by the Independent Gambling Authority of South Australia*. Adelaide, Australia. https://www.yumpu.com/en/document/read/50780225/inquiry-into-management-of-gaming-machine-numbers/35

Doran, B. J., McMillen, J., & Marshall, D. C. (2007). A GIS-based investigation of gaming venue catchments. *Transactions in GIS*, *11*, 575–595. https://doi.org/10.1111/j.1467-9671.2007.01061.x

Doran, B. J., & Young, M. (2010). Predicting the spatial distribution of gambling Vulnerability: An application of gravity modeling using ABS mesh blocks. *Applied Geography*, *30*, 141–152. https://doi.org/10.1016/j.apgeog.2009.04.002

Doughney, J. (2002). Socio-economic banditry: Poker machines and income redistribution in Victoria. In T. Eardley & B. Bradbury (Eds.), *Competing visions: Refereed proceedings of the National Social Policy Conference 2001* (pp. 136–154). SPRC Report 1/02. Sydney, Australia: Social Policy Research Centre, University of New South Wales. https://www.aspc.unsw.edu.au/sites/www.aspc.unsw.edu.au/files/uploads/files/002-NSPC01_RefereedProceedings.pdf

Dowling, N., Smith, D., & Thomas, T. (2005). Electronic gaming machines: Are they the “crack-cocaine” of gambling? *Addiction*, *100*, 33–45. https://doi.org/10.1111/j.1360-0443.2005.00962.x

Entwisle, B., Rindfuss, R. R., Walsh, S. J., Evans, T. P., & Curran, S. R. (1997). Geographic information systems, spatial network analysis, and contraceptive choice. *Demography*, *34*, 171–187. https://doi.org/10.2307/2061697

Feld, S. L. (1981). The focused organization of social ties. *The American Journal of Sociology*, *86*, 1015–1035. https://doi.org/10.1086/227352

Ferris, J., Wynne, H. (2001). *The Canadian Problem Gambling Index: User manual*. Ottawa, Canada: Canadian Centre on Substance Abuse.

Fridberg, T., & Birkelund, J. (2016). *Gambling and gambling problems in Denmark 2005–2016*. Copenhagen, Denmark: The Danish Center for Social Science Research.

Ganzeboom, H. B., & Treiman, D. J. (2010). *Occupational stratification measures for the New International Standard Classification of Occupations (ISCO-08), with a discussion of the new classification*. N.p.: n.p. http://www.harryganzeboom.nl/isol/isol2010c2-ganzeboom.pdf

Gerstein, D. R., Hoffmann, J., Larison, C., Engelman, L., Murphy, S., Palmer, A., Chuchro, L., Toce-Gerstein, M., Johnson, R., Buie, T., Hill, M. A., Volberg, R. A., Harwood, H., Tucker, A., Christiansen, E., Cummings, W., & Sinclair, S. (1999).

Gambling impact and behavior study: Report to the National Gambling Impact Study Commission. Chicago, IL: National Opinion Research Center at the University of Chicago. http://www.norc.org/PDFs/publications/GIBSFinalReportApril1999.pdf

Gordon, R., & Reith, G. (2019). Gambling as social practice: A complementary approach for reducing harm? *Harm Reduction Journal*, *16*, 64. https://doi.org/10.1186/s12954-019-0342-2

Griffiths, M. D. (2010). Problem gambling in Europe: What do we know? *Casino and Gambling International*, *6*, 81–84. https://www.researchgate.net/publication/285738751_Problem_gambling_in_Europe_What_do_we_know

Griffiths, M. D., Hayer, T., & Meyer, G. (2009). Problem gambling: A European perspective. In G. Meyer, T. Hayer, & M. Griffiths (Eds.), *Problem gambling in Europe: Challenges, prevention, and interventions* (pp. xix-xxx). New York, NY: Springer.

Griffiths, M. D., Wardle, H., Orford, J., Sproston, K., & Erens, B. (2010). Gambling, alcohol, consumption, cigarette smoking and health: Findings from the 2007 British Gambling Prevalence Survey. *Addiction Research & Theory*, *18*, 208–223. https://doi.org/10.3109/16066350902928569

Hansen, M. B., & Rossow, I. M. (2012). Does a reduction in the overall amount of gambling imply a reduction at all levels of gambling? *Addiction Research and Theory*, *20*, 145–52. https://doi.org/10.3109/16066359.2011.605968

LaBrie, R. A., Nelson, S. E., LaPlante, D. A., Peller, A. J., Caro, G., & Shaffer, H. J. (2007). Missouri casino self-excluders: Distributions across time and space. *Journal of Gambling Studies*, *23*, 231–43. https://doi.org/10.1007/s10899-006-9037-1

LaBrie, R. A., Shaffer, H. J., LaPlante, D. A., & Wechsler, H. (2003). Correlates of college student gambling in the United States. *Journal of American College Health*, *52*, 53–62. https://doi.org/10.1080/07448480309595725

LaPlante, D. A., & Shaffer, H. J. (2007). Understanding the influence of gambling opportunities: Expanding exposure models to include adaptation. *American Journal of Orthopsychiatry*, *77*, 616–623. https://psycnet.apa.org/doi/10.1037/0002-9432.77.4.616

Lester. D. (1994). Access to gambling opportunities and compulsive gambling. *International Journal of the Addictions*, *29*, 1611–1616. https://doi.org/10.3109/10826089409047954

Livingstone, C. (2001). The social economy of poker machine Gambling in Victoria. *International Gambling Studies*, *1*, 46–65. http://dx.doi.org/10.1080/14459800108732287

Livingstone, C., & Adams, A. (2010). Harm promotion: Observations on the symbiosis between government and private industries in Australasia for the development of highly accessible gambling markets. *Addiction*, *106*, 3–8. https://doi.org/10.1111/j.1360-0443.2010.03137.x

Livingstone, C., & Woolley, R. (2007). Risky Business: A few provocations on the regulation of electronic gaming machines. *International Gambling Studies*, *7*, 361–376. http://dx.doi.org/10.1080/14459790701601810

Lund, R. L. (2018). From the dark end of the street to the bright side of the road: Automated redistricting of areas using physical barriers as dividers of social space. *Methodological Innovations*, *11*(3), 1–15. https://doi.org/10.1177/2059799118814386

Lund, R. L. (2019). *Dissecting the local-territorial scale and the social mechanism of place* [Doctoral dissertation, Department of Sociology and Social Work, Aalborg University, Aalborg campus]. https://vbn.aau.dk/files/319147947/PHD_Rolf_Lyneborg_Lund_E_pdf.pdf

Lund, R. L. (2020). Moving to prosperity? The effect of prolonged exposure to neighborhood deprivation. *Scandinavian Journal of Educational Research*, *64*, 471–487. https://doi.org/10.1080/00313831.2019.1577753. https://sfx.aub.aau.dk/sfxaub?sid=pureportal&doi=10.1080/00313831.2019.1577753

Macdonald, L., Olsen, J. R., Short, N. K., & Ellaway, A. (2018). Do "environmental bads" such as alcohol, fast food, tobacco, and gambling outlets cluster and co-locate in more deprived areas in Glasgow City, Scotland? *Health and Place*, *52*, 224–231. https://doi.org/10.1016/j.healthplace.2018.04.008

Markham, F., Young, M., & Doran, B. (2017). Improving spatial microsimulation estimates of health outcomes by including geographic indicators of health behaviour: The example of problem gambling. *Health and Place*, *46*, 29–36. https://doi.org/10.1016/j.healthplace.2017.04.008

Marshall, D. J. (1998). Missing the jackpot? The proliferation of gambling in Australia and its effect on local communities. *Australian Geographical Studies*, *36*, 237–247. https://doi.org/10.1111/1467-8470.00054

Marshall, D. J. (2005). The gambling environment and gambler behaviour: Evidence from Richmond-Tweed, Australia. *International Gambling Studies*, *5*, 63–83. https://doi.org/10.1080/14459790500099471

Marshall, D. J., & Baker, R. (2002). The evolving market structures of gambling: Case studies modelling the socioeconomic assignment of gaming machines in Melbourne and Sydney, Australia. *Journal of Gambling Studies*, *18*, 273–291. https://doi.org/10.1023/a:1016847305942

Martins, S. S., Stor, C. L., Lee, G. P., & Ialongo, N. S. (2013). Environmental influences associated with gambling in young adulthood. *Journal of Urban Health*, *90*, 130–40. https://doi.org/10.1007/s11524-012-9751-1

McLeroy K. R., Bibeau D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education & Behavior*, *15*, 351–77. https://doi.org/10.1177/109019818801500401

McMillen, J., & Doran, B. (2006). Problem gambling and gaming machine density: Socio-spatial analysis of three Victorian localities. *International Gambling Studies*, *6*, 4–37. https://doi.org/10.1080/14459790600644093

Orford, J. (2005). Complicity on the river bank: The search for truth about problem gambling: Reply to the commentaries. *Addiction*, *100*, 1235–1239. https://doi.org/10.1111/j.1360-0443.2005.01219.x

Orford, J., Wardle, H., Griffiths, M., Sproston, K., & Erens, B. (2007). The role of social factors in gambling: Evidence from 2007 British Gambling Prevalence Survey. *Community Work & Family*, *13*, 257–270. https://doi.org/10.1080/13668803.2010.488101

Pearce, J., Mason, K., Hiscock, R., & Day, P. (2008). A national study of neighbourhood access to gambling opportunities and individual gambling behaviour. *Journal of Epidemiology & Community Health*, *62*, 862–868. https://doi.org/10.1136/jech.2007.068114

Productivity Commission. (1999). *Australia's gambling industries* (Report number 10). Canberra, Australia: AusInfo. https://www.pc.gov.au/inquiries/completed/gambling/report/gambling1.pd

Raisamo, S., Toikka, A., Selin, J., & Heiskanen, M. (2019). The density of electronic gambling machines and area-level socioeconomic status in Finland: A country with a legal monopoly on gambling and a decentralised system of EGMs. *BMC Public Health*, *19*, 1198. https://doi.org/10.1186/s12889-019-7535

Reith, G. (2007). Situating gambling studies. In G. Smith, D. Hodgins, & R. William (Eds.), *Research and measurement issues in gambling studies* (pp. 3–29). Amsterdam, The Netherlands: Elselvier.

Reith, G. (2012). Beyond addiction or compulsion: The continuing role of environment in the case of pathological gambling. *Addiction*, *107*, 1736–1737. https://psycnet.apa.org/doi/10.1111/j.1360-0443.2012.03669.x

Rintoul, A. C., Livingstone, C., Mellor, A. P., & Jolley, D. (2013). Modelling vulnerability to gambling related harm: How disadvantage predicts gambling losses.

Addiction Research & Theory, *21*, 329–338. https://psycnet.apa.org/doi/10.3109/16066359.2012.727507

Risbeck, M., & Paulsson, K. (2009). *SWELOGS: A population study on gambling and health 2008/09: A presentation of key findings from the first data collection*. Paper presented at the European Association for Study of Gambling, Stockholm, Sweden

Robitaille, É., & Herjean, P. (2008). An analysis of the accessibility of video lottery terminals: the case of Montréal. *International Journal of Health Geographics*, *7*, 2. https://doi.org/10.1186/1476-072X-7-2

Shaffer, H. J., LaBrie, R. A., & LaPlante, D. (2004). Laying the foundation for quantifying regional exposure to social phenomena: Considering the case of legalized gambling as public health toxin. *Psychology of Addictive Behaviors*, *18*, 40–48. https://psycnet.apa.org/doi/10.1037/0893-164X.18.1.40

Storer, J., Abbott, M., & Stubbs, J. (2009). Access or adaptation? A meta-analysis of surveys of problem gambling prevalence in Australia and New Zealand with respect to concentration of electronic gaming machines. *International Gambling Studies*, *9*, 225–244. https://doi.org/10.1080/14459790903257981

St.-Pierre, R. A., Walker, D. M., Derevensky, J., & Gupta, R. (2014). How availability and accessibility of gambling venues influence problem gambling: A review of the literature. *Gaming Law Review and Economics*, *18*, 150–172. https://doi.org/10.1089/glre.2014.1824

Vasiliadis, S. D., Jackson, A. C., Christensen, D., & Francis, K. (2013). Physical accessibility of gaming opportunity and its relationship to gaming involvement and problem gambling: A systematic review. *Journal of Gambling Issues*, *28*, 1–46. https://doi.org/10.4309/jgi.2013.28.2

Volberg, R. A., Abbott, M. W., Rönnberg, S., & Munck, I. M. E. (2001). Prevalence and risks of pathological gambling in Sweden. *Acta Psychiatrica Scandinavica*, *104*, 250–256. https://psycnet.apa.org/doi/10.1034/j.1600-0447.2001.00336.x

Ward, A. D., McIvor, J. T., & Bracewell, P. (2020). The geographic distribution of gaming machine proceeds in New Zealand. *Kōtuitui: New Zealand Journal of Social Sciences Online*, *15*, 54–74. https://doi.org/10.1080/1177083X.2019.1640752

Wardle, H., Keily, R., Gaynor, A., & Reith, G. (2012). "Risky places"? Mapping gambling machine density and socio-economic deprivation. *Journal of Gambling Studies*, *30*, 201–212. https://doi.org/10.1007/s10899-012-9349-2

Welte, J. W., Barnes, G. M., Wieczorek, W. F., Tidwell, M.-C. O., & Hoffman, J. H. (2007). Type of gambling and availability as risk factors for problem gambling:

A Tobit regression analysis by age and gender. *International Gambling Studies*, *7*, 183–198. https://doi.org/10.1080/14459790701387543

Welte, J. W., Wieczorek, W. F., Barnes, G. M., & Tidwell, M.-C. O. (2006). Multiple risk factors for frequent and problem gambling: Individual, social and ecological. *Journal of Applied Social Psychology*, *36*, 1548–1568. https://doi.org/10.1111/j.0021-9029.2006.00071.x

Welte, J. W., Wieczorek, W. F., Barnes, G. M., Tidwell, M.-C. O., & Hoffman, J. H. (2004). The relationship of ecological and geographic factors to gambling behavior and pathology. *Journal of Gambling Studies*, *20*, 405–23. https://doi.org/10.1007/s10899-004-4582-y

Wheeler, B., Rigby, J., & Huriwai, T. (2006). Pokies and poverty: Problem gambling risk factor geography in New Zealand. *Health & Place*, *12*, 86–96. https://doi.org/10.1016/j.healthplace.2004.10.011

White, M. J., Kim, A. H., & Glick, J. E. (2005). Mapping social distance: Ethnic residential segregation in a multiethnic metro. *Sociological Methods & Research*, *34*, 173–203. https://dx.doi.org/10.1177/0049124105280198

Wooldridge, J. M. (1995). Selection corrections for panel data models under conditional mean independence assumptions. *Journal of Econometrics*, *68*, 115–132. https://doi.org/10.1016/0304-4076(94)01645-G

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data* (2nd ed.). Cambridge, MA: MIT Press.

Xouridas, S., Jasny, J., & Becker, T. (2016). An ecological approach to electronic gambling machines and socioeconomic deprivation in Germany. *Journal of Gambling Issues*, *33*, 82–102. https://psycnet.apa.org/doi/10.4309/jgi.2016.33.6

Young, M., Markham, F., & Doran, B. (2012). Too close to home? The relationships between residential distance to venue and gambling outcomes. *International Gambling Studies*, *12*, 257–273. https://doi.org/10.1080/14459795.2012.664159

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