



The temporal variation of ethnic segregation in a city: Evidence from a mobile phone use dataset



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ABSTRACT

The aim of this study is to determine the temporal variation of ethnic segregation in the city of Tallinn, the capital of Estonia. We employ data on mobile-phone use to compare variations in segregation indices during the day, the week, and the year. The results indicate that the locations of people are more segregated at night, with considerably less segregation during the daytime. The segregation is significantly lower on workdays compared to weekends. Segregation is also lower during summer holidays compared to the winter working period. The results show that although places of residence are segregated, different ethnic groups use the city together during the day, which increases the potential for interethnic contacts. The results demonstrate also that temporal segregation indices based on mobile-phone use are considerably lower than segregation indices of places of residence that are derived from the census.

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1. Introduction

Spatial separation of some population groups from others is one of the most important population processes in cities. The spatial segregation of minorities is usually deemed to be negative because the isolation of minorities in excessively segregated cities is associated with problems in education, employment, poverty, safety, and health care (Cutler and Glaeser, 1997; Massey et al., 1987). Studies have indicated that there is more interethnic contact in areas that contain mixed ethnic groups, which are generally accompanied by “knowledge spillover” (Audretsch and Feldman, 1996; Glaeser, 1999) and a decrease in ethnic prejudice (Pettigrew and Tropp, 2008).

Segregation is a spatial process, and one of the traditional methods for measuring segregation is by indexes, which enables researchers to measure and compare the level of segregation of different population groups. Ethnic segregation has been assessed mainly on the basis of places of residence (Massey and Denton, 1988; Musterd and van Kempen, 2009), work (Ellis et al., 2004; Wang, 2010) and leisure activities (Deepak, 2007; Floyd, 1999). Studies have shown that residence-based segregation differs from segregation in other areas. While studies have found that segregation is lower at places of work than at places of residence, the results of studies on segregation during leisure activities are contradictory (Blumen and Zamir, 2001; Ellis et al., 2004; Schnell and Benjamini, 2001; Silm and Ahas, 2012; Silm et al., 2011).

An assessment of segregation on the basis of a study of single-activity places (residence, place of work, leisure) may not show the complete picture of the potential for assimilation, because the activities and person-to-person contacts of an individual may take place across many different places. Thus, studying segregation across the whole activity-space is considered

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more appropriate and more valuable than studying single-activity places (Schnell and Benjamini, 2001; Silm et al., 2011; Wong and Shaw, 2011). The need for an integral approach to the activity space also arises from the considerable increase in the mobility of people today (Sheller and Urry, 2006).

An unexplored area in segregation studies is the temporal dimension of segregation. Studies that are based on single activities and places give some information about the temporality of segregation. Place of residence measures are associated with evening and nighttime sleeping areas, place of work measures are associated with places that are used in daytime (Ellis et al., 2004), and leisure-time activity measures are associated with weekends (Floyd, 1999; Gramann, 1996). However, segregation has not been studied directly from the temporal perspective. Drawing parallels with spatial segregation, it is important to know *when* the potential of interethnic contacts is low and when it is high. This could offer one possibility for a better understanding of segregation in the current fast-paced and mobile world, and a basis for the review of integration and planning policies. The movement of immigrant groups in Europe and elsewhere in recent years has created the need to update current integration policies (Freeman, 2013; Simon et al., 2011).

There is very little suitable data available for the study of the temporality of segregation. Censuses and registers provide data on only one area and are temporally limited. Interviews, surveys, and travel diaries can be helpful, but they usually focus on relatively short periods of time. Two suitable sources of data are various GPS-based and mobile phone-based tracking systems that collect data (Ahas and Mark, 2005; Ahas et al., 2008; González et al., 2008; Palmer et al., 2013). These devices enable one to collect data over a longer period and across all of the activity spaces of individuals, which makes it possible to study segregation from a temporal perspective.

The aim of the present study is to determine the temporal variation of ethnic segregation across the day, the week, and the year in the city of Tallinn, the capital of Estonia. We use the passive mobile-phone positioning data of 5200 residents of Tallinn over the course of three years. This tracking data allows us to study the locations of people continuously through time and space during a long time-period. We measure segregation for 3-h periods using traditional segregation indices – the index of dissimilarity (ID), the modified index of isolation (MII), and the location quotient (LQ) method – and compare the results with residence-based indices based on 2000 census data. We assume that an understanding of the temporal dimension of segregation will provide new knowledge about segregation that will be valuable for updating integration policies.

2. Theoretical background

2.1. Spatial processes of segregation

Residence-based segregation (i.e., the extent to which two or more ethnic groups live separately from one another) has been studied extensively. Massey and Denton (1988) identified five clearly definable and measurable spatial dimensions in a study of the segregation of places of residence: evenness, exposure, concentration, centralisation, and clustering (Massey and Denton, 1988). These same dimensions are also appropriate for an analysis of spatial segregation in other activity places (e.g., places of work and leisure), and for analyzing spatial segregation from a temporal perspective.

The most commonly measured dimension of segregation is evenness, which “refers to the differential distribution of two social groups among areal units in a city” (Massey and Denton, 1988: 283). A minority group is considered to be segregated if it is unevenly distributed compared to the majority group. Segregation is highest when no members of the minority and majority groups are located (living) in the same spatial unit, and segregation is lowest when there is the same relative number of members of the minority and majority groups in all spatial units. The second most widely studied dimension of segregation is exposure, which “refers to the degree of potential contact, or the possibility of interaction, between minority and majority group members within geographic areas of a city” (Massey and Denton, 1988: 287). Other dimensions of segregation discussed by Massey and Denton (1988) – e.g., concentration, centralisation, and clustering – have been measured less often in empirical studies.

Analyses of these dimensions of segregation have shown that people of similar ethnic or racial backgrounds tend to live close to each other in segregated, homogenous, and distinct neighbourhoods. The previous tendency has been that minority groups live mainly in poorer inner-city neighbourhoods, whereas the main ethnic group lives mainly in affluent and prestigious neighbourhoods of the metropolitan area (Massey and Denton, 1993; Wilson, 1987). The last decades have taken place a change – minority groups have also moved out to the suburbs and the boundaries between some races or ethnic groups (such as blacks and whites) have blurred (Iceland, 2009; Logan and Stults, 2011).

Studies of segregation in work places have shown a concentration of minority groups in certain employment niches and workplaces (Blumen and Zamir, 2001; Åslund and Skans, 2010; Ellis et al., 2004). It has been suggested that segregation in places of residence and segregation in places of work are connected, but do not overlap fully. Workplace-based segregation is lower than residence-based segregation (Åslund and Skans, 2010; Ellis et al., 2004). Outside of the place of residence and the place of work, ethnic differences have been studied mainly through single measures of leisure activities, such as going to church (Dougherty, 2003), casinos (Deepak, 2007), or national parks (Floyd, 1999; Gramann, 1996).

The results of leisure-time segregation studies are somewhat contradictory. On one hand, it has been found that ethnic groups often spend their free time in separate areas (Gobster, 2002; Johnson et al., 1998; Silm and Ahas, 2012) and prefer different activities (Floyd, 1999). On the other hand, it has been found that activities, such as engaging in sport and attending events, may take immigrants out of their ethnic networks, which may facilitate the formation of interethnic contacts, and

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