Segregation and individual employment: a longitudinal study of neighborhood effects

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Abstract

In this article, we study whether individuals who reside in segregated neighborhoods in Sweden have lower propensity to be employed. We employ full population micro-data, which allow us to follow the same group of individuals over 21 years and make it possible to apply an individual fixed effects strategy to reduce issues of self-selection and individual heterogeneity. The results show that individuals in segregated neighborhoods are less likely to be employed compared to individuals living in non-segregated neighborhoods. This observation is most significant in metropolitan regions. Furthermore, the relationship appears to be particularly attributed to males of foreign background. However, it is not the spatial separation between immigrants and natives that lies behind the negative relationship between segregation and employment, but rather the distress of neighborhoods.

JEL Classifications J21 · J61 · R23

1 Introduction

Sweden has received a large number of immigrants over the last decades. The accumulative immigration in Sweden the past three decades is equal to around one-fourth of the current population. At the same time, unemployment among natives is 3.8% and 15.4% among foreign born (Statistics Sweden 2019). Residential segregation may be one (of several) reasons for this observed difference. In previous literature, segregation is identified as a potential source of both positive and negative externality effects. The positive side of segregation springs mostly from social networks between individuals belonging to certain groups, based on, for example, common ethnic origin. Such networks can work as intermediators of employment through the spreading of information and the sharing of contacts (Bayer et al. 2008). On the

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other hand, spatial and social separation may cause lock-in effects, which will isolate already disadvantaged groups and prevent integration into both the labor market and with society at large (Kain 1968; Massey et al. 1987). From this perspective, residential segregation may increase the obstacles immigrants face in entering the labor market. Hence, in this paper, we analyze how residential segregation is related to the propensity of being employed for individuals of both foreign and native background residing in various types of regions.

Residential segregation is commonly defined as a spatial separation of individuals of different ethnic backgrounds. Additionally, segregation has a strong socioeconomic aspect since individuals of different ethnic backgrounds commonly reside in areas with different socioeconomic status and are thus exposed to different sets of opportunities. In Sweden, neighborhoods with a large share of individuals of foreign background are often characterized by high unemployment, low incomes, low education levels, and cheap housing, as well as social exclusion, violence, and even criminality (cf. Edling 2015). Hence, ethnic segregation tends to go hand in hand with socioeconomic status.

For individuals and households, employment is an obvious factor that determines welfare consumption opportunities. In addition, individuals are the micro-foundation of the economy, which implies that disturbances to the labor market may have long-run consequences for the economic development of a country. One reason for large differences in employment rates, as well as unemployment, between natives and foreign born is likely the relatively lower education levels among foreign born. Individuals with relatively low expected productivity, which is partly determined by education (cf. Mincer 1958, 1974), face large challenges in labor markets characterized by high entry wages and few low-skilled jobs, such as in Sweden. In addition, language skills and knowledge of the national labor market are also likely to affect the probability that a person will be employed, areas where immigrants commonly have a disadvantage. These factors are connected to the time spent in a country, which has been found to positively affect the employment among foreign born in Sweden (Rooth 1999; Nekby 2003). The issue of low “Sweden-specific skills” is larger in the metropolitan regions, where newly arrived immigrants often reside (Huggare et al. 2010).

In our empirical analysis, we employ full population micro-data that allow us to conduct a longitudinal study of individuals from 1990 to 2011 in Sweden. This implies that we follow the same group of individuals, that is, the 1990 cohort, over 21 years. The length of the panel is one strength of the study, since neighborhood characteristics tend to change slowly over time. Another strength of the study is that we follow the same individuals during the whole time period. This allows us to introduce individual fixed effects to control for unobserved time-invariant characteristics that influence both where a person chooses to “locate” and whether that person is employed. This is crucial since there is a large self-organizing aspect to residential segregation, where individual preferences and choices, which are dependent on, for example, income levels, play an important role (see, e.g., Schelling 1971). In addition, we control for observable time-variant individual characteristics that may explain lower employment among individuals with foreign background, such as education and time spent in the country. The geo-coding of the data allows us to define

the neighborhoods at a small, albeit not too small, geographical scale. Our neighborhoods are represented by church parishes, which have an average population of approximately 10,000.¹ This is another strength of the study, since parishes resemble actual neighborhoods with strong historical roots, and are not contemporary spatial units constructed for administrative or statistical purposes. Finally, we control for characteristics of the labor market region.

The results of the study have bearing on policy concerning both integration and urban planning. In particular, the results show that it is not the spatial separation of individuals with different backgrounds that lies behind the negative relationship between neighborhood segregation and individual employment, but rather the distress of neighborhoods, here measured in terms of non-employment rates. This shows that more distressed neighborhoods provide fewer opportunities for labor market participation, no matter the degree of ethnic segregation. Hence, residing in socioeconomically weak neighborhoods seems to pose barriers for labor integration, which may be particularly challenging for individuals who are already disadvantaged in the labor market.

The rest of the paper is organized as follows. Section 2 provides further background and motivation for the study, which includes theory and previous empirical research, as well as a description of the development of segregation in Sweden between 1990 and 2011. This is followed by an overview of the data, method, and variables in Sect. 3. Section 4 presents the empirical results and an analysis of them, while Sect. 5 concludes the paper.

2 Background and motivation

2.1 The development of segregation in Sweden 1990–2011

In order to describe the development of segregation in Sweden, we need to use some measure of the phenomenon. A common measure of segregation used in empirical studies is the dissimilarity index² (see, for example, Tauber and Tauber 1965; Cutler and Glaeser 1997; Cutler et al. 1999; Aldén et al. 2015), which dates back to Hoover (1941). This index measures how minority and majority group individuals are distributed across sub-areas, such as neighborhoods of a region. The more evenly the minority group is distributed relative to the majority group, the lower is the level of segregation. Following Duncan and Duncan (1955), the dissimilarity index, D , is calculated as follows:

$$D = \frac{1}{2} \sum_{k=1}^n \left| \frac{b_k}{B} - \frac{a_k}{A} \right| \quad (1)$$

¹ We use the definition of church parishes in Sweden from 1999-12-31 (before the State Church in Sweden was decoupled from the State Government).

² See Massey and Denton (1988) for a description of five dimensions of segregation and 20 indices.

Fig. 1 Change in average dissimilarity index in Sweden 1990–2011 (population-weighted average)

where b_k is the number of minority group individuals in neighborhood k , B the corresponding number in the respective region, a_k the number of majority group individuals in neighborhood k , and A the corresponding number in the region. n is the number of neighborhoods in a region. D ranges from 0 to 1 and can be interpreted as the proportion of minority group individuals in the region that need to change neighborhood of residence in order to achieve the same geographical distribution as the majority group. In the present paper, the dissimilarity index is based on the distribution of minority and majority group individuals across parishes (which represent neighborhoods) within labor market regions. Each of the 2513 parishes in Sweden is located in one of the 93 labor market regions in Sweden.³ Minority group individuals are those with a foreign background, classified according to Statistics Sweden as either foreign born or native born with two foreign-born parents. Second generation immigrants are thus included in the minority group, because the cultural identities of parents are often upheld in the next generation (Waters 1994; Portes and Rumbaut 2005). Individuals born in Sweden with at least one native-born parent are categorized in the majority group.

To assess the overall change in segregation between 1990 and 2011 in Sweden, we calculate the yearly dissimilarity index for each of the 93 labor market regions and weight it with regard to population. This is summarized in Fig. 1.

The dissimilarity index for Sweden calculated for 1990 is approximately 0.1944, which implies that, on average, 19.44% of the individuals with foreign background needed to move to another neighborhood in order to reach the same geographical distribution as the majority population. Figure 1 shows a continuous increase in average segregation in Sweden, and in 2011, the weighted dissimilarity index reached approximately 0.2471, which implies an increase in average

³ The 93 regions correspond to the earlier classification of labor market regions in Sweden by the Swedish Agency for Economic and Regional Growth (www.tillvaxtverket.se).

Fig. 2 Levels of segregation 2011 (left map) and changes in segregation within Swedish regions, 1990–2011 (right map). *Notes:* Four regions have missing values. These regions are located in the sparsely populated northern part of Sweden and have only one parish each, which implies that it is not possible to calculate a dissimilarity index for them

segregation by 5% units. The results of Aldén et al. (2015), who calculate the dissimilarity index for the 12 largest Swedish municipalities between 1990 and 2007, point in the same direction, particularly for the earlier part of the period. This development of residential segregation supports the conclusion from the bid-rent model with ethnic externalities described in Sect. 2.2, namely that segregation moves toward a complete spatial separation of different groups of the population.

Figure 1 gives an overall view of the change in segregation in Sweden between 1990 and 2011, and regional discrepancies are hence suppressed. To shed some light on differences among regions, Fig. 2 shows the level of segregation in 2011 as well as the change in the dissimilarity index between 1990 and 2011.

In 2011, the most segregated region in Sweden was Södertälje, which is located just south of the capital region of Stockholm. In 2011, the dissimilarity index for Södertälje was 0.3924, which implies that almost 40% of the population with a foreign background needed to relocate within the region to reach the same distribution as the population with native background. This figure can be compared to 28% in 1990. This increase implies that Södertälje is one of the regions

where segregation increased the most between 1990 and 2011. The right map in Fig. 2 shows that a majority of regions in Sweden saw an increase in segregation between 1990 and 2011, albeit in varying degrees.

Figure 2 also shows that segregation is not merely an urban phenomenon. The three metropolitan regions in Sweden: Stockholm (Sthlm), Gothenburg (Gbg), and Malmö, do show up among the 25 most segregated regions, but considerably smaller regions and smaller cities also have relatively high degrees of segregation. In general, segregation and increases in segregation are greater in the more densely populated southern part of Sweden.

2.2 Segregation, non-market interactions, and employment opportunities

To understand the fundamental mechanisms in the housing market that influence the outcome in terms of ethnic segregation, we can refer to the neoclassical bid-rent theory, building on the seminal model presented by Alonso (1964), Mills (1967), and Muth (1969), often referred to as the Mills–Muth model. The original version of this model assumes a monocentric urban region with a central business district in its core. An extension of this model is to introduce *prejudice* as preference of an individual (or household) toward some other group of the population. This type of modification was presented by Yinger (1976), while Fujita (1989) presents a comprehensive overview of the application of the bid-rent model, including racial and ethnic perspectives, where neighborhood externalities are considered.

To understand the outcome of such bid-rent models, we follow Fujita (1989) and assume a situation with two groups of the population, *A* and *B*. *A*-households have an aversion toward living close to *B*-households, while *B*-households are indifferent in this respect. The utility function for *A*-households can then be written as $U_A(z, s, E(k))$, where $E(k)$ is the externality *A*-households experience at location *k* (the level of experienced externality at *k* is negatively associated with closeness to *B*-households at *k*) given the spatial distribution of *B*-households in the city, *z* is the composite consumer good, and *s* is the consumption of land or the lot size of the house. Transportation costs increase with distance *r* from the CBD of a location *k*. It is assumed that U_A increases when $E(k)$ increases (Fujita 1989):

$$\frac{\partial U_A(z, s, E(k))}{\partial E(k)} > 0 \quad (2)$$

Using the bid-rent function including externalities at a given location, several models have been formulated to explain spatial distributions of population groups in a city region. Bailey (1959) and Rose-Ackerman (1975, 1977) elaborate on the so-called *border-model*, which assumes that the two groups of households are completely segregated in a city, where one of the groups occupies the inner (outer) part of the city and $E(k)$ increases as the distance from the border dividing the inner and outer parts of the city increases. The strength of the prejudices will influence the rate of speed as well as the magnitude for these processes as they develop over time. However, Schelling (1971) shows theoretically that even weak preferences can lead to fully segregated neighborhoods. For Sweden, these conclusions are supported

empirically by Aldén et al. (2015), who show that increases in neighborhood concentration of immigrants are associated with decreases in the native population.

Kain (1968) argues that residential segregation isolates minority groups from job locations, which imposes spatial barriers. This spatial mismatch implies high costs due to physical distance, a situation that discourages individuals from seeking employment in other areas. In addition, the spatial barriers imply informational barriers about job opportunities as well as potential labor market discrimination against minority groups from employers in areas populated mainly by the majority group. Kain (1968) even argues that what is usually called employment discrimination is in fact a result of housing segregation. In addition, Kain (1968) presents an early empirical contribution, showing a negative relationship between housing segregation and the employment of minority group individuals. There is also a large body of studies on the connection between spatial mobility and social mobility (see Massey et al. 1987 for an overview).

As discussed already by Kain (1968), spatial separation reinforces social distance since segregation relegates already disadvantaged individuals to areas with fewer opportunities and less amenities (Logan 1978). Residential segregation also implies less interaction with natives and fewer incentives to acquire country-specific human capital and language skills, which might have long-term effects on labor market outcomes (cf. Chiswick and Miller 1995; Edin et al. 2003; Delander et al. 2005; Aldén and Hammarstedt 2014). These effects may be exacerbated by, for example, a lack of knowledge and information in segregated neighborhoods (cf. O'Regan and Quigley 1998) or lower educational aspirations among parents in these neighborhoods combined with school segregation (cf. Mookherjee et al. 2010; Böhlmark et al. 2016). Borjas (1995) argues that individuals brought up in more-advantageous environments have higher productivity due to exposure to beneficial social and economic factors, including role models (Ginther et al. 2000). Hence, observing and interacting with neighbors gives rise to externality effects that affect human capital accumulation (Glaeser et al. 2000) as well as behavior (cf. Debreu 1952; Schelling 1973; Becker 1974).

Earlier empirical studies mostly find a negative relationship between segregation and labor market outcomes (Leonard 1987; Cutler and Glaeser 1997; Collins and Margo 2000). However, there is a large self-organizing aspect to residential segregation, where individual choices and preferences play an important role in housing decisions (see, e.g., Schelling 1971). Some empirical studies that address this endogeneity find that the effect of segregation on labor market outcomes is still negative (Cutler and Glaeser 1997), while others find a nonnegative effect (Edin et al. 2003; Cutler et al. 2008; Andersson et al. 2014). This can be explained by the potential benefits of segregation, which are related to social interactions. The residential concentration of certain groups, in terms of, for example, age, education, race, and family status, enhances the formation of group-specific social networks, which increases access to job opportunities through, for example, job referrals (cf. Rees 1966; Bayer et al. 2008; Calvó-Armengol and Jackson 2004). In addition, residential concentration may be necessary to achieve critical mass to support firms and other institutions targeting group-specific needs (Waldfogel 2003). Andersson et al. (2014), who

apply similar Swedish micro-data, as well as method, to the present study,⁴ find that the effect of immigrant concentration on immigrant income is positive. The authors argue that this could be due to the Swedish welfare system and redistributive policies.

Zenou (2007) shows that individuals who live in segregated areas rely on strong social ties, that is, family and friends in their immediate neighborhood, for information. If these strong ties are unemployed, the chances of finding a job through the social network are also limited (cf. Hensvik and Nordström Skans 2016). Indeed, Granovetter (1973, 1974, 1983, 1995) argues that strong ties are inferior to weak ties in providing employment opportunities. This argument is supported empirically by Alesina et al. (2015), who show that a background in strong family societies has a negative effect on employment. Additionally, Clark (2003) argues that the impact of unemployment on utility is reduced if a higher proportion of the neighbors are unemployed. This implies that segregated areas with lower socioeconomic status may have a social norm of unemployment, which decreases the incentives to actively seek a job. Social norms may thus be self-enforcing at both the individual and the societal level (cf. Dal Bó and Terviö 2013).

2.3 Employment decisions

Individuals supply labor, and firms demand labor on the labor market. Both the demand side and the supply side of individual employment can be modeled using discrete choice theory. An individual will actively search for a job (supply labor) only if the expected utility from working exceeds the expected utility from not working. Based on neoclassical economic theory, individual i 's utility, U , is a function of consumed goods, z , and leisure time, F , which are both subject to constraints. First, the individual cannot spend more than the total income, I , which, if the individual is working, is equal to non-labor income, $\bar{I}$, plus the hours spent at work times the wage, wh , minus the costs of getting to and from the place of work, C . Second, the individual has a time constraint, where her total time, T , is allocated between work, h , and leisure. If individual i is not working, there is no time constraint and the total income is the sum of non-labor income and welfare allowances, S .

Neighborhood externalities, $E(k)$, enter the utility function as a separate factor. Following the discussion above of unemployment as a social norm, residing in a neighborhood with lower socioeconomic status decreases the relative utility from being employed, while it increases the relative utility from not being employed. As opposed to the bid-rent models above, $E(k)$ is experienced by individuals from both groups of the population (A and B). Hence, with $E(k)$ defined as above,⁵ U^{work} is an

⁴ The present study differs from Andersson et al. (2014) in that they use a shorter time period, 1991–2006; they include only individuals who live in the three metropolitan areas in Sweden, namely Stockholm, Gothenburg, and Malmö; they proxy neighborhoods by Small Areas for Market Statistics (SAMS); and they study income.

⁵ That is, the level of experienced externality at k is negatively associated with closeness to B -households at k . Here, however, it is not the mere presence of B -households that constitutes the externality

increasing function of $E(k)$, while $U^{\text{non-work}}$ is a decreasing function of $E(k)$. The supply side can thus be specified as follows (cf. Gravelle and Rees 2004):

$$U^{\text{work}}(z, F, E(k)) = f((wh - C, \bar{I}), T - h, E(k)) \quad (3)$$

$$U^{\text{non-work}}(z, F, E(k)) = f((S, \bar{I}), T, E(k)) \quad (4)$$

$$Y^{\text{supply}} = \begin{cases} 1 & \text{if } \exp(U^{\text{work}}) \geq \exp(U^{\text{non-work}}) \\ 0 & \text{if } \exp(U^{\text{work}}) < \exp(U^{\text{non-work}}) \end{cases} \quad (5)$$

On the demand side, a firm will only employ an individual if the expected value of her marginal product, $E[\text{MP}_L]$, is at least as high as the wage the firm has to pay. An individual's expected productivity, $E[\text{MP}_L]$, is largely a function of education, ED, and experience, EX (cf. Mincer 1958, 1974). However, working in a primarily Swedish context commonly requires specific skills, such as those pertaining to language, culture, and social norms. The accumulation of country-specific human capital, SE, is thus another factor that affects the expected productivity of an individual. Since the exposure to beneficial social and economic factors in more-prosperous neighborhoods increases the productivity of individuals (Borjas 1995), segregation, $E(k)$, also enters the function for productivity. $E[\text{MP}_L]$ is thus an increasing function of $E(k)$. The demand side of employment is specified below:

$$E[\text{MP}_L] = f(\text{ED}, \text{EX}, \text{SE}, E(k)) \quad (6)$$

$$Y^{\text{demand}} = \begin{cases} 1 & \text{if } E[\text{VMP}_L] \geq w \\ 0 & \text{if } E[\text{VMP}_L] < w \end{cases} \quad (7)$$

The probability that an individual is employed, $\Pr(Y = 1)$, is thus a function of a combination of factors from both the demand side and the supply side of the labor market. In addition, the probability of employment may depend on the type of region, R , the individual lives in, since employment opportunities are commonly greater in more-urban regions. This could be due to more-efficient matching on the labor market, which is identified by Duranton and Puga (2004) as a micro-foundation of agglomeration economies. Åslund et al. (2010) show that for refugees arriving to Sweden in 1990–1991, being placed in a location with good access to jobs had a positive effect on the probability of being employed in 1999.

This gives the following theoretical model:

$$\Pr(Y = 1) = f(w, C, \bar{I}, T, h, S, \text{ED}, \text{EX}, \text{SE}, E(k), R) \quad (8)$$

Not all of these variables are possible to capture empirically. This specifically concerns the supply side of employment, shown by Eqs. (3)–(5), except for the variable of main interest; segregation.

Footnote 5 (continued)

effect but rather the socioeconomic status of segregated neighborhoods. As discussed above, in the Swedish case, the socioeconomic status is negatively correlated with the presence of B-households.

3 Method

3.1 Data and identification strategy

This study relies on full population geo-coded micro-data from Statistics Sweden. This type of data provides unique possibilities for conducting research with individuals as the units of observation. In addition, the geographical location for each individual is known, which allows for the inclusion of variables describing the surrounding milieu, such as the neighborhood. The neighborhoods defined as church parishes in Sweden are fixed during the whole time period. In general, parishes are more representative of actual neighborhoods in relatively denser areas. The data stretch from 1990 to 2011, which provides a relatively long panel. This is necessary to study neighborhood effects in an individual fixed effects setting, since neighborhood characteristics tend to change slowly over time. This implies that the identification comes mostly, but not solely, from individuals who move between neighborhoods. To test the robustness of the results, we also calculate the neighborhood variables at the scale of Small Areas for Market Statistics (SAMS).⁶ In Sweden, there are approximately 9000 SAMS, which imply that these are, on average, smaller geographical units than parishes.

The data availability allows us to construct a data set in panel form that follows the same individuals over 21 years, 1990–2011.⁷ Section 2.1 shows that on a regional level, there have been relatively large changes in segregation levels since 1990, which implies that there have been redistributions of individuals with native and foreign background on the neighborhood level. This is supported by Table 5, which shows that even though the between variation for foreign–native difference is greater, there is considerable within variation. Hence, even for individuals who do not move, there is variation over time in the neighborhood characteristics.

To include only those individuals who were potentially in the labor force for the whole period, we exclude those who in 1990 were younger than 20 or older than 40 years of age. We cannot know whether all included individuals were continuously in the labor force, since the data do not provide information on labor market participation of non-employed, that is, whether they are active job-seekers or not. This implies that we can measure the *non*-employment rate but not the *un*employment rate. To follow the same individuals during the whole period, we also exclude those who for some reason disappear from the data set during the time period.⁸ In

⁶ SAMS are based on municipality sub-areas in larger municipalities and voting districts in smaller municipalities. The use of SAMS to estimate neighborhood effects has been criticized by Amcoff (2012), who shows large regional variations that mainly result from differences in the construction of the SAMS in different municipalities.

⁷ The first year is not counted since neighborhood characteristics are measured by a 1-year lag; see below.

⁸ Despite this, the panel is not perfectly balanced, since there are missing data for some individuals in some years. On average, the individuals show up in the data 20.8 times, which implies that missing values are not a major issue.

total, we follow 2,254,375⁹ individuals, of which approximately 16% have a foreign background. The data set does not allow for distinguishing among different types of foreign background, since it is not possible to trace individuals to their parents. Country of origin, grouped in regions, is thus only known for foreign-born individuals. Additionally, the data do not allow for distinguishing between labor migrants and, for example, refugee migrants.

In the estimations, we apply individual fixed effects to control for unobserved time-invariant individual characteristics, such as innate abilities, social skills, childhood experiences, and cultural background. These characteristics may influence both where a person chooses to locate and whether that person is employed, which implies a correlation between explanatory variables and the error term. If not controlled for, this endogeneity induces biased and inconsistent estimates. Applying individual fixed effects thus reduces issues of self-selection and omitted variable bias (cf. Weinberg et al. 2004; Andersson et al. 2014). This is crucial in studies of neighborhood effects due to the large degree of endogeneity in the location decisions of individuals. Another endogeneity issue arises from the collection of the data, namely that employment status is being reported in November, while location is based on place of residence by December 31st. This implies that an individual may have moved during the year, which infers a change in the neighborhood characteristics due to being employed. The reverse causality is addressed by measuring the neighborhood characteristics with a 1-year lag. However, the issue of reverse causality may not be fully eliminated since individuals can move due to knowing that they will start a new employment the next year. As robustness test, we introduce 2-year lags for the neighborhood variables.

Even though the measures described above may not completely eliminate endogeneity, they reduce it to a large extent. Both (time-invariant) unobserved individual heterogeneity and reverse causality are controlled and tested for in the estimations and by the robustness tests. One issue that does remain is the potential influence on employment status of time-variant unobserved individual characteristics, since these cannot be captured by the fixed effects estimation. This may affect, for example, the self-selection of movers, that is, that individuals with poor employment prospects are more likely to move to distressed neighborhoods that offer cheap housing, while employed high income individuals have greater possibilities to move to economically prosperous neighborhoods. This type of self-selection may induce biased results if individuals' employment prospects are changing over time due to either unobservable learning or changes in their underlying abilities.

3.2 Empirical model and estimation

The dependent variable, y_{it} , takes the value one if individual i is employed at time t , and zero otherwise. The probability that $y_{it} = 1$ is given by some function of the

⁹ Due to the fixed effects estimation, the identification is based on the 1,119,305 individuals who change employment status during the time period.

covariates x_{it} , where x_{it} is theoretically defined in Sect. 2.3, while the empirically measured variables are presented in Sect. 3.3.

With a binary dependent variable, estimating logit or probit models may seem as the natural choice. However, as pointed out by Angrist and Pischke (2009), the nonlinearity of these models provides complications when working with panel data. Given that ordinary least squares (OLS) estimates and probit marginal effects have been shown to be empirically very similar (Angrist and Pischke 2009), we estimate linear probability models instead of the alternative nonlinear probit or logit models.¹⁰

The estimated linear probability model, in a panel setting using two-way fixed effects, can be specified as follows:

$$y_{it} = \alpha_i + \gamma_t + x'_{it}\beta + u_{it} \quad (9)$$

where α_i captures the individual fixed effects, which controls for time-invariant unobservable individual heterogeneity. In fixed effects estimation, the α_i s are eliminated due to the within transformation. γ_t represents year fixed effects, which are introduced to control for business cycles, that is, that the probability of being employed is generally higher (lower) in times of expansion (recession). u_{it} is the usual error term.

To test for differences between males and females with native and foreign backgrounds, we introduce interaction terms between neighborhood segregation and gender/background. In addition, since the relationship between segregation and employment may vary across different types of regions, we run category-wise models for individuals residing in metropolitan, city, and rural regions, respectively.¹¹

3.3 Variables

The covariates x_{it} consist of variables at three different levels: individual, neighborhood, and regional. The variables of main interest concern neighborhood characteristics, while individual and regional characteristics control for factors that may affect the probability that an individual is employed. A complete list of variables is given in Table 1. The motivations for these variables are found in Sects. 2.2 and 2.3 as well as in the following subsections. All variables are constructed based on the full

¹⁰ Logit models of a 5% sample show that the results are robust across model specifications. The linear probability model implies that the error term is heteroscedastic and, hence, a type 1 error. Nevertheless, since we use the complete number of observations (not a random selection) and are mostly interested in the calculated marginal effect, we choose to employ the linear probability model.

¹¹ In this classification, the 290 Swedish municipalities are categorized into the three region types based on commuting patterns among municipalities as well as population size and density within municipalities (Swedish Board of Agriculture 2013). In *metropolitan* municipalities, located only in Stockholm, Gothenburg or Malmö, 100% of the population lives in cities or within a 30–60 km radius of cities (depending on the size of the city). *City* municipalities have a population of at least 30,000 or a center with a population of at least 25,000. *City* municipalities include smaller municipalities that border larger municipalities and where more than 50% of the (night) population are outgoing commuters. The remaining municipalities are categorized as *rural*.

Table 1 List of variables

Variable	Measured as
Employed	Dummy = 1 if individual <i>i</i> is employed at year <i>t</i> . Dependent variable
Individual characteristics	
Education length	Dummies for: Elementary school (base) High school Bachelor Master PhD
Education type	Dummies for 2-digit educational groups (see Table 7)
Family status	Dummies for: Single with no children under 18 (base) Married/co-habitants with no children under 18 Single with at least one child under 18 Married/co-habitants with at least one child under 18
Age	Dummies for: Aged 20–30 (base) Aged 31–40 Aged 41–50 Aged 51–61
Years in Sweden	Dummies for: Non-immigrant (base) 1–5 years since immigration 6–10 years since immigration 11–15 years since immigration 16–20 years since immigration 21–25 years since immigration > 25 years since immigration
Gender and foreign background (only used with interaction terms due to no within variation)	Dummies for: Foreign female (base) Foreign male Native female Native male
Neighborhood characteristics	
Foreign–native difference	Difference between the percentage of the minority group, individuals of foreign background, and the percentage of the majority group, individuals of native background (in terms of regional population of each group)
Non-employment rate	Percentage of non-employed 20–64 years
Neighborhood population density (ln)	Population per km ² , log transformed
Regional characteristics	
Regional population density (ln)	Population per km ² , log transformed
Employment rate	Percentage of employed 20–64 years

Table 2 Descriptive statistics for neighborhood foreign–native difference

Foreign–native difference			
Mean	0.00		
SD	2.77	Foreign share $\left(\frac{b_k}{B}\right)$	Native share $\left(\frac{a_k}{A}\right)$
Min	−22.67	54.41	77.08
Max	39.36	60.83	21.47

2513 neighborhoods over 22 years

population micro-data from Statistics Sweden. Descriptive statistics are presented in Table 5, while Table 6 provides a correlation matrix.

3.3.1 Neighborhood characteristics

To measure segregation at the neighborhood level, we start from the dissimilarity index, Eq. (1), which provides a segregation value for the region. However, segregation is expected to affect individuals differently, depending on what type of neighborhood they reside in. A high level of regional segregation indicates that there are large differences in population background between neighborhoods. Hence, to calculate the level of segregation in each neighborhood, only the first step of Eq. (1) is applied, that is, the difference between the neighborhood's share of the region's population with foreign background and the corresponding share of the population with native background. This measure can be denoted as foreign–native difference, Diff_k , calculated for each neighborhood k according to Eq. (10):¹²

$$\text{Diff}_k = \left[\frac{b_k}{B} - \frac{a_k}{A} \right] \times 100 \quad (10)$$

where b_k is the number of individuals with foreign background in neighborhood k , B the corresponding number in the respective region, a_k the number of individuals with native background in neighborhood k , and A the corresponding number in the region. We do not take the absolute value of this difference, since a neighborhood with a (large) positive value is fundamentally different from a neighborhood with a (large) negative value. Theoretically, Diff_k ranges from -100 to 100 , where -100 implies that the whole population of the majority group in a region resides in neighborhood k , while no one from the minority group resides there. The opposite is the case if Diff_k equals 100 . In the data applied in the present paper, Diff_k ranges from approximately -23 to approximately 39 , with a mean of about zero. Descriptive statistics for the foreign–native difference is shown in Table 2.

A value of zero implies that equal shares of the two groups reside in neighborhood k , for example, 20% of all individuals with a foreign background in the region and 20% of all individuals with a native background in the region.¹³ When using

¹² For consistency between explanatory variables, $\frac{b_k}{B} - \frac{a_k}{A}$ is multiplied by 100.

¹³ Note that this does not imply that 50% of the neighborhood population belongs to each group.

the term *segregated* for neighborhoods, we refer to neighborhoods with positive values, that is, neighborhoods where a larger proportion of the region's individuals with a foreign background reside than the corresponding proportion of individuals with native background. This does not imply that neighborhoods with non-positive values are excluded in the empirical analysis. Table 2 shows that in the most segregated neighborhood, 61% of the foreign population (of that region) resides, while only 21% of the native population (of that region) lives there. The least segregated neighborhood has 77% of the region's native population and 54% of the corresponding foreign population. These figures indicate that both the most and the least segregated neighborhoods are relatively large in terms of regional population.

To control for the degree of agglomeration of the neighborhood, we include a measure of population density in all estimations. In addition, as a second step, we introduce the non-employment rate to control for the socioeconomic status of the neighborhood. This shows whether it is segregation per se, that is, the spatial separation of individuals with native and foreign background, that is related to employment or whether it is the neighborhoods' level of distress.

3.3.2 Individual characteristics

Even though the focus of the paper is on the neighborhood effects described above, it is necessary to control for individual characteristics. Time-invariant observable (such as gender and foreign background) and unobservable/unmeasurable characteristics (such as social ability, cultural values, and childhood experiences) are controlled for through individual fixed effects estimation. Other individual characteristics vary over time and are hence introduced as explanatory variables.

Mincer (1958, 1974) developed the famous Mincer wage equation, in which market wages are determined by education and experience. These variables are introduced to capture the skills and abilities of the individuals, and the estimated parameters measure the returns to schooling and experience, respectively. While Mincer focuses on the effect on earnings, the same reasoning can be applied for employment opportunities, since, as shown in Sect. 2.3, the probability of being employed is likely to increase with education and work experience. In the present paper, education is measured in both length and type. Regarding education length, we distinguish among different years of schooling: 9 years of elementary school or less (base), high school, 3–4 years of higher education (bachelor), five or more years of higher education (master), and PhD studies. Education type is categorized based on 2-digit educational codes (see Table 7). Potential experience is measured by the age of the individual in intervals to allow for nonlinear effects. Additional individual characteristics controlled for concern family status, which shows whether individuals are single or married, as well as whether they have children below the age of 18. Having a spouse and/or children to support may push individuals to more actively seek employment, since they place higher value on the consumption of goods. The individual family members may also add up and strengthen the overall social network of the family, which can contribute positively to the probability of being employed. However, the effect on labor supply of having a family is ambiguous, since individuals may also value leisure time higher.

As outlined in the introduction, Rooth (1999) and Nekby (2003) show that time spent in Sweden has a positive impact on the probability of being employed. The time spent in a country is positively related to the knowledge of, for example, the language, the culture, the social norms, and the labor market in that country. Hence, to control for the accumulation of “country-specific” human capital, years since immigration, in 5-year intervals, is introduced as an explanatory variable.

3.3.3 Regional characteristics

To control for agglomeration economies, especially the fact that employment opportunities are greater in urban regions due to more-efficient matching in the labor market (Duranton and Puga 2004), we include population density in the labor market region. The employment rate in the labor market region is introduced as a more direct measure of the quality of the labor market.

4 Empirical results

To estimate the effects of segregation on individual employment, we include all control variables at the individual and regional level, as described above. Table 3 presents the results, where segregation, measured by foreign–native difference at the neighborhood level (Eq. 10), is the variable of main interest. To test for differences between males and females of native and foreign backgrounds, we introduce interaction terms between neighborhood segregation and gender/background in all specifications. Specification (1) includes all available observations, while specifications (2) and (3) restrict the sample to individuals residing in metropolitan and city regions, respectively. The models are statistically significant, as are most of the coefficients.

The estimates for individuals residing in rural regions are not shown in Table 3 since neighborhood segregation (foreign–native difference) is insignificant in general as well as for both genders and backgrounds. This is not unexpected considering that the degree of segregation is generally smaller in more sparsely populated rural regions, especially in the north of Sweden (Fig. 2), which implies less differences in segregation at the neighborhood level.

Table 3 shows that after controlling for time-variant observable individual and regional characteristics as well as time-invariant observable and unobservable individual characteristics in specification (1), the relationship between neighborhood segregation, measured as foreign–native difference, and individual employment is statistically significant and negative. This can be interpreted as if individuals who live in more-segregated neighborhoods are less likely to be employed, which supports the line of thinking of Kain (1968). Specification (1) also shows that the negative relationship is especially strong for males of foreign background, as compared to females of foreign background (base category) as well as natives.

The negative effect of segregation on employment seems to be driven by males of foreign background, which is supported by specification (2)–(3). It is possible that this is due to cultural differences between men and women. This phenomenon may, for example, be supported if males of foreign background are more likely than

Table 3 Estimated relationships between neighborhood segregation, measured as foreign–native difference, and individual employment

	(1) All	(2) Metro	(3) City
Individual characteristics			
Education			
High school	0.1001*** (0.0013)	0.0852*** (0.0023)	0.1061*** (0.0025)
Bachelor	0.3456*** (0.0015)	0.3322*** (0.0027)	0.3490*** (0.0029)
Master	0.5063*** (0.0027)	0.4797*** (0.0041)	0.5162*** (0.0050)
PhD	0.4207*** (0.0023)	0.4073*** (0.0036)	0.4105*** (0.0040)
Education dummies	Yes	Yes	Yes
Family status			
Married	−0.0001 (0.0003)	0.0025*** (0.0005)	0.0023*** (0.0006)
Single with child	0.0105*** (0.0004)	0.0095*** (0.0007)	0.0105*** (0.0007)
Married with child	0.0087*** (0.0003)	0.0097*** (0.0004)	0.0095*** (0.0005)
Age			
31–40	0.0428*** (0.0003)	0.0375*** (0.0005)	0.0423*** (0.0006)
41–50	0.0486*** (0.0004)	0.0419*** (0.0006)	0.0498*** (0.0007)
50–	0.0116*** (0.0005)	0.0072*** (0.0008)	0.0131*** (0.0009)
Years in Sweden			
1–5	−0.0923*** (0.0029)	−0.0782*** (0.0041)	−0.1211*** (0.0060)
6–10	−0.0646*** (0.0025)	−0.0634*** (0.0034)	−0.0864*** (0.0052)
11–15	0.0021 (0.0023)	0.0036 (0.0031)	−0.0116** (0.0047)
16–20	0.0315*** (0.0023)	0.0341*** (0.0029)	0.0244*** (0.0044)
21–25	0.0308*** (0.0020)	0.0365*** (0.0028)	0.0263*** (0.0042)
26–	0.0115*** (0.0019)	0.0161*** (0.0025)	0.0138*** (0.0038)
Neighborhood characteristics			
Foreign–native difference	−0.0005*** (0.0000)	−0.0016*** (0.0003)	−0.0001 (0.0002)
Foreign–native difference interaction			
Foreign male	−0.0010*** (0.0002)	−0.0010** (0.0005)	−0.0013*** (0.0003)
Native female	−0.0000 (0.0002)	0.0005 (0.0004)	−0.0006** (0.0002)
Native male	−0.0001 (0.0002)	0.0000 (0.0004)	−0.0007*** (0.0002)
Neighborhood population density (ln)	0.0023*** (0.0001)	0.0026*** (0.0001)	0.0020*** (0.0002)
Regional characteristics			
Regional population density (ln)	0.0216*** (0.0003)	0.0282*** (0.0015)	0.0273*** (0.0013)
Employment rate	0.0059*** (0.0001)	0.0044*** (0.0002)	0.0057*** (0.0002)
Constant	0.1300*** (0.0057)	0.1772*** (0.0154)	0.1328*** (0.0141)
Individual fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
F-value	5884.51***	1941.39***	1671.38***
R ² within	0.0383	0.0373	0.0370
No. of observations	46,823,221	15,965,807	13,848,148
No. of groups	2,254,375	902,676	845,275

All individuals (1), individuals residing in metropolitan regions (2), and individuals residing in city regions (3)

Table 3 (continued)

***Denotes significance at the 1% level; **denotes significance at the 5% level. Robust SE in parenthesis. The dependent variable is binary and equal to 1 if individual i is employed at year t

women to participate in socially and geographically bounded networks in segregated neighborhoods. As Granovetter (1973, 1974, 1983, 1995) argues, such social networks are commonly characterized by strong ties, which may even decrease employment opportunities if the ruling social norms do not promote activities such as working or active job-seeking.

Specifications (2) and (3) also indicate that even though segregation is not merely an urban phenomenon, the negative relationship between segregation at the neighborhood level and individual employment appears to be a primarily urban problem. Hence, the effect is not only driven mainly by males of foreign background, but by males of foreign background that reside in metropolitan regions. However, even though the relationship is stronger for males of foreign background, neighborhood segregation is also significant in general. On the other hand, for individuals residing in city regions, segregation is negatively related to the employment of natives as well as males of foreign background, albeit not females of foreign background.

To illustrate the economic significance of the results, we compare a person with foreign background living in the most segregated neighborhood (with value 39 in foreign–native difference) with a person with similar characteristics living in the least segregated neighborhood (with value -23 in foreign–native difference), which implies a change by 62 units in neighborhood foreign–native difference. For an individual residing in a metropolitan region, this difference is associated with a decrease in the likelihood of being employed by approximately 0.1¹⁴ on the scale from 0 to 1, or 10% points, keeping all other variables constant. For a male of foreign background, there is an added decrease of 6% points.¹⁵ Hence, segregation can be argued to have a fairly sizable relationship with employment, particularly for males with foreign background in metropolitan regions.

These results are strengthened by the estimations that employ Small Areas for Market Statistics (SAMS) to represent neighborhoods. Since the magnitudes of the estimated variables are larger when employing the smaller geographical units, the results for foreign–native difference in Table 3 are most likely not over-estimations of the relationship between neighborhood segregation and employment. The estimated relationships using 2-year lags for the neighborhood variables are similar to the results shown in Table 3, albeit somewhat smaller. However, most individuals may not be forward-looking enough to motivate 2-year lags.

4.1 Socioeconomic status of the neighborhood

As already mentioned, neighborhoods in Sweden, as in many other countries, that hold a large proportion of individuals with foreign background are characterized by

¹⁴ $0.0016395 \times 62 = 0.1016$.

¹⁵ $0.0009871 \times 62 = 0.0612$.

lower socioeconomic status. Hence, we re-estimate the relationship between neighborhood segregation and individual employment, including the neighborhood non-employment rate as a measure of socioeconomic status. This shows whether it is the spatial separation of individuals with native and foreign background that is negatively associated with employment or whether it may be the distress of neighborhoods. The results for the neighborhood characteristics are presented in Table 4.¹⁶

In addition to the results shown in Table 4, we have tested whether the effect of socioeconomic status on individual employment is stronger for more-segregated neighborhoods, by use of an interaction term. The interaction between the neighborhood non-employment rate and foreign–native difference is, however, insignificant throughout the specifications in Table 4.

Table 4 shows that controlling for the socioeconomic status of the neighborhood changes the relationship between residential segregation per se and employment quite drastically. For females of foreign background as well as for natives, the relationship turns positive, or at least nonnegative,¹⁷ which is in line with the results by Andersson et al. (2014), who show a positive effect of immigrant concentration on incomes, using a similar fixed effects approach on Swedish micro-data. The positive effect may be a result of social networks, which can be argued to form more easily among individuals in segregated neighborhoods (cf. Zenou 2007). However, since the added estimate for males of foreign background points to an insignificant or even negative relationship between segregation and employment, the explanation provided by Andersson et al. (2014) may be more likely. Hence, the positive effect may reflect an added effort and effectiveness of Swedish labor market institutions in segregated neighborhoods, which individuals of native background are better equipped to take advantage of. The estimations employing SAMS as well as 2-year lags for the neighborhood variables strengthen this conclusion.

The negative association between segregation and employment found in Table 3 correlates with the lower non-employment rate that commonly prevails in distressed and segregated neighborhoods. However, since the interaction term between non-employment and foreign–native difference is insignificant, the negative effect of the non-employment rate on individual employment is not stronger in more ethnically segregated neighborhoods.

The results point to that it is not segregation in terms of spatial separation between individuals of native and foreign background that causes unemployment. It is rather the lower socioeconomic status, or distress of neighborhoods, here measured as the share of non-employed. In Sweden, one typical aspect of the ethnic segregation process is that individuals with foreign background are more and more agglomerated in distressed neighborhoods, characterized by inexpensive housing, low employment levels, low incomes, and low education levels. The bivariate correlation between the foreign–native difference and the non-employment rate at

¹⁶ The results for the remaining variables are robust to the inclusion of the neighborhood non-employment rate. Full regression results can be obtained from the corresponding author upon request.

¹⁷ The added decrease for males and females of native background is either insignificant or too small to offset the positive estimate for foreign–native difference in specifications (4)–(7).

Table 4 Estimated relationships between neighborhood segregation, measured as foreign–native difference, and individual employment, controlling for socioeconomic status, measured as the neighborhood non-employment rate

	(4) All	(5) Metro	(6) City	(7) Rural
Foreign–native difference	0.0006*** (0.0002)	0.0011*** (0.0004)	0.0010*** (0.0002)	0.0005* (0.0003)
Foreign–native difference interaction				
Foreign male	−0.0010*** (0.0002)	−0.0010** (0.0005)	−0.0013*** (0.0003)	−0.0003 (0.0004)
Native female	−0.0004** (0.0002)	−0.0000 (0.0004)	−0.0006** (0.0002)	0.0000 (0.0003)
Native male	−0.0005*** (0.0002)	−0.0006 (0.0004)	−0.0007*** (0.0002)	0.0001 (0.0003)
Non-employment rate	−0.0017*** (0.0000)	−0.0015*** (0.0000)	−0.0016*** (0.0001)	−0.0027*** (0.0000)

***Denotes significance at the 1% level, **denotes significance at the 5% level, and *denotes significance at the 10% level. Robust SE in parenthesis. The dependent variable is binary and equal to 1 if individual i is employed at time t

the neighborhood level has increased continuously between 1990 and 2011, from 0.13 in 1990 to 0.38 in 2011,¹⁸ which indicates that labor market effects tied to the process of segregation have been accelerating during the past decades. Hence, one significant challenge with segregation is perhaps not the spatial separation but rather that segregation relegates individuals who already face challenges in the labor market to areas with fewer opportunities for employment (cf. Kain 1968; Massey et al. 1987). This increases the distress and thus decreases the opportunities in these neighborhoods even further, which indicate that spatial and socioeconomic separation go hand in hand.

The lower employment rates in segregated areas may have significant implications for individual networks. Even though social networks may form more easily in segregated neighborhoods, due to individuals sharing similar backgrounds, these networks may not be very efficient from a labor market perspective. In addition, if the individuals in segregated neighborhoods interact mainly within strong ties networks, as found by Zenou (2007), the opportunities for finding a job are limited (cf. Granovetter 1973, 1974, 1983, 1995). This would mean that the potential benefits of segregation, such as group-specific networks, may not be as valid in the Swedish context. As already discussed, distressed neighborhoods in Sweden, as well as in other countries, are characterized by a relatively large immigrant population. However, segregated neighborhoods in Sweden are commonly composed of a wide variety of ethnic groups, with little or nothing in common besides being immigrants (Andersson and BråmÅ 2004). This provides less breeding ground for the creation of group-specific social networks.

As opposed to the results on foreign–native difference, the main relationship between neighborhood non-employment and individual employment can now be found for individuals living in rural regions. The status of the neighborhood is thus less relevant for individual employment in metropolitan and city regions, which can be explained by the fact that larger labor market regions offer more opportunities for employment than smaller labor market regions (cf. Duranton and Puga 2004). The estimations using 2-year lags as well as the smaller SAMS to approximate neighborhoods show very similar results to Table 4, albeit with somewhat smaller relationships between the non-employment rate and individual employment.

4.2 Control variables

The results for the control variables show that education is a key factor for employment. For example, having a master's degree is related to a 0.5, or 50% points, higher level of the likelihood to be employed. However, the base category in the estimations is individuals with 9 years of compulsory schooling or less, which is a group with low employment rates that faces very large challenges in the Swedish labor market due to the absence of low-skilled jobs and high entry wages. Hence,

¹⁸ The correlation based on the observations used in the empirical estimation on the full sample, specification (1) in Table 2, shows an increase from 0.32 in 1990 to 0.50 in 2011.

the results confirm the importance of higher education for labor market outcomes (cf. Mincer 1958, 1974).

The results regarding civil status show that being married, and especially having children, is positively related to employment [except from only married in specification (1)]. As expected, experience, measured as age, has a nonlinear effect on employment. Table 2 shows that the likelihood of being employed increases with age but at a decreasing rate. Also years spent in Sweden is significantly related to employment of foreign-born individuals, which confirms previous research (Rooth 1999; Nekby 2003). Compared to native Swedes (base category), foreign born who has been in Sweden for up to 10 years is less likely to be employed, while foreign born with more than 15 years in the country is even more likely to be employed than natives.

Both control variables at the regional level are highly statistically significant. Population density is positively related to employment and an increase in the employment rate by 10% points is related to a six-percentage point increase in the likelihood to be employed. This reflects that employment opportunities are greater in regions with a high degree of urbanization as well as regions with a well-functioning labor market, which may be due to more-efficient matching when there is a greater variety in both employees and employers (Duranton and Puga 2004).

5 Conclusions

The purpose of the present study is to test whether individuals that reside in more ethnically segregated neighborhoods have a lower propensity to be employed. Since there is a large self-organizing aspect to location choices and, hence, segregation, we apply an individual fixed effects strategy that reduces issues of self-selection and omitted variable bias. Due to access to Swedish full population micro-data, we can follow the same individuals for 21 years. The results show that neighborhood segregation is significantly negatively associated with individual employment, which is mainly driven by males of foreign background. We also find that segregation is a challenge primarily for metropolitan regions.

In Sweden, ethnically segregated neighborhoods are commonly characterized by low socioeconomic status, which implies low employment levels, low average incomes, low education levels, cheap housing, and social exclusion. These neighborhoods provide fewer opportunities for employment, which may be particularly challenging for individuals who are already disadvantaged in the labor market. Individuals of foreign background, especially newly arrived immigrants, may be particularly disadvantaged due to, for example, language, cultural, and social barriers, as well as a lack of networks to the Swedish labor market. Indeed, when we control for the non-employment rate of the neighborhood, we find that it is not segregation per se, that is, the spatial separation of individuals with different background, that is related to lower employment, but rather the distress of neighborhoods. Hence, individuals that reside in socioeconomically weaker neighborhoods have lower propensity to be employed, no matter the degree of ethnic segregation.

This implies that it is important to view segregation from a socioeconomic, rather than an ethnic, perspective and to create opportunities for individuals in both the housing market and the labor market. The integration of individuals with foreign background into society at large thus calls for policies that facilitate job integration as well as housing integration. This may entail a more flexible labor market, strategies for mixed housing also at the neighborhood level, and, not least, the promotion of higher education. The results of this study show that higher education is an important determinant for employment.

Indeed, the empirical results give some indications that males of foreign background may be affected also by ethnic segregation per se. This is an aspect to analyze deeper in future studies, especially regarding different foreign backgrounds, which cannot be controlled for in the present paper. The group of individuals of foreign background is far from homogenous, which implies variations in cultural background as well as in cultural distance between individuals with different ethnic backgrounds and individuals with native background. Such variations across ethnic groups are likely to affect the prospects of integration in the labor market and with society at large. Also, in this paper we follow individuals who resided in Sweden already in 1990. Considering different immigration waves and increases in segregation since 1990, studies following more recent cohorts can add to the knowledge on the relationship between segregation and labor market outcomes. Hence, further studies are encouraged to dig deeper into this issue and distinguish among different foreign backgrounds as well as different periods of time.

In addition, the present study connects employment to the current place of residence. However, as touched upon in Sect. 2.2, the economic outcomes of individuals may also be affected by their childhood experiences, which include the characteristics of the neighborhood/s where they grew up. This is an additional topic for further research. Finally, to understand the mechanisms behind the relationship between segregation and labor market outcomes, studies on social networks are highly relevant.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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Appendix

See Tables 5, 6, and 7.

Table 5 Descriptive statistics for the panel data

Variable	Variation	Mean	SD	Min	Max	Obs.
Individual characteristics						
Education	Overall	2.01	0.63	1	5	$N=49,882,290$
	Between		0.60	1	5	$n=2,272,181$
	Within		0.20	-1.81	5.10	$\bar{T}=21.95$
Education dummies	Overall	38.83	27.56	1	86	$N=49,353,324$
	Between		26.18	1	86	$n=2,254,500$
	Within		8.65	-42.31	119.96	$\bar{T}=21.89$
Family status	Overall	2.69	1.33	1	4	$N=50,076,254$
	Between		0.95	1	4	$n=2,276,196$
	Within		0.93	-0.17	5.55	$\bar{T}=22$
Age	Overall	2.49	0.91	1	4	$N=50,076,312$
	Between		0.59	1.55	3.45	$n=2,276,196$
	Within		0.69	0.40	4.49	$\bar{T}=22$
Years in Sweden	Overall	1.47	1.48	1	7	$N=50,076,312$
	Between		1.42	1	7	$n=2,276,196$
	Within		0.41	-4.25	7.20	$\bar{T}=22$
Gender	Overall	0.49	0.50	0	1	$N=50,076,312$
	Between		0.50	0	1	$n=2,276,196$
	Within		0.00	-0.46	1.45	$\bar{T}=22$
Foreign background	Overall	0.12	0.33	0	1	$N=50,076,312$
	Between		0.33	0	1	$n=2,276,196$
	Within		0	0.12	0.12	$\bar{T}=22$
Neighborhood characteristics						
Foreign-native difference	Overall	1.21	4.81	-22.67	39.36	$N=50,021,791$
	Between		4.18	-15.02	33.83	$n=2,276,191$
	Within		2.40	-44.50	49.98	$\bar{T}=21.98$
Non-employment rate	Overall	23.60	7.11	0	68.35	$N=50,021,791$
	Between		5.39	7.89	59.64	$n=2,276,191$
	Within		4.63	-25.47	71.01	$\bar{T}=21.98$
Neighborhood population density (ln)	Overall	5.13	2.21	-2.67	9.95	$N=50,021,791$
	Between		2.02	-2.51	9.92	$n=2,276,191$
	Within		0.90	-5.27	15.22	$\bar{T}=21.98$
Regional characteristics						
Regional population density (ln)	Overall	3.90	1.25	-1.57	5.62	$N=50,021,791$
	Between		1.21	-1.52	5.62	$n=2,276,191$
	Within		0.33	-2.81	10.55	$\bar{T}=21.98$
Employment rate	Overall	75.83	3.92	51.52	89.52	$N=50,021,791$
	Between		2.29	56.98	85.22	$n=2,276,191$
	Within		3.18	46.76	105.61	$\bar{T}=21.98$

The mean for the dummy variables, especially for education categories and family status that are measured on a nominal scale, is rather uninformative. For these variables, the main aim of the table is to show the within variation. Since foreign background is time-invariant, within variation is zero. For gender, within variation is low though not zero (0.003), which reflects that 120 of the individuals in the data set do change sex between 1990 and 2011

Table 6 Correlation matrix

	1	2	3	4	5	6	7	8	9	10
Individual characteristics										
1. Education	1									
2. Education dummies	0.43	1								
3. Family status	0.05	0.03	1							
4. Age	0.00	-0.01	-0.06	1						
5. Years in Sweden	-0.06	-0.05	0.00	0.13	1					
Neighborhood characteristics										
6. Foreign-native difference	-0.04	-0.01	-0.04	-0.00	0.09	1				
7. Non-employment rate	-0.05	-0.03	-0.10	-0.08	0.15	0.38	1			
8. Neighborhood population density (ln)	0.12	-0.06	-0.16	-0.06	0.14	0.16	0.31	1		
Regional characteristics										
9. Regional population density (ln)	0.08	-0.06	-0.05	-0.00	0.14	-0.12	0.01	0.66	1	
10. Employment rate	0.01	-0.00	-0.02	0.09	-0.01	0.03	-0.48	-0.04	-0.05	1

Table 7 Educational codes

Educational code (Sun2000Inr)	Education focus
01	General education
08	Reading and writing for adults
09	Personal development
14	Pedagogics and teaching
21	Arts and media
22	The humanities
31	Social and behavioral science
32	Journalism and information
34	Business
38	Law and legal science
42	Biology and environmental science
44	Physics, chemistry, and geoscience
46	Mathematics and natural science
48	Computer science
52	Engineering: technical, mechanical, chemical, and electronics
54	Engineering: manufacturing
58	Engineering: construction
62	Agriculture
64	Animal health care
72	Health care
76	Social work
81	Personal services
84	Transport services
85	Environmental care
86	Security

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