Immigrants' settlement patterns in the city of Naples

I modelli insediativi degli immigrati nella città di Napoli

Giuseppe Gabrielli, Angelo Mazza, and Salvatore Strozza

Abstract Residential segregation is the outcome of both economic inhomogeneities within the urban space and attraction among individuals sharing the same ethnicity. Here we focus on the settlement patterns originated by different groups of immigrants in the city of Naples. We use the inhomogeneous L-function for measuring segregation due to spatial attraction, while adjusting for the effects of inhomogeneity. Monte Carlo simulations have been used to build confidence envelopes for the null hypothesis of absence of spatial attraction. All nationalities exhibited significant spatial attraction at all considered distances, except for Romania and Poland. However, spatial attraction resulted much stronger for immigrants from Pakistan, China, and Sri Lanka.

Abstract La segregazione residenziale è la risultante di disomogeneità economiche all'interno dello spazio urbano e dell'attrazione tra individui della stessa etnia. In questo lavoro, noi considerazione i modelli insediativi originati da diversi gruppi di immigrati stranieri nella città di Napoli ed impieghiamo la funzione L disomogenea per misurare la segregazione causata dall'attrazione spaziale, tenendo sotto controllo le disomogeneità spaziali. Tramite simulazioni Monte Carlo abbiamo costruito degli intervalli di confidenza per l'ipotesi nulla di assenza di attrazione. Tutte le nazionalità analizzate hanno mostrato un'attrazione spaziale significativa a tutte le distanze considerate, ad eccezione di Rumeni e Polacchi. Un'attrazione più forte è stata osservata per gli immigrati provenienti dal Pakistan, Cina e Sri Lanka.

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1 Introduction

Residential ethnic segregation is the outcome of several, interacting forces. Following a classical paper by Schelling (1971), we may identify three major sources of segregation. One source refers to ethnic discriminatory rules, enforced by law and traditions in certain countries and times. Another source is spatial inhomogeneity within the urban space, mainly in the costs of residential property and in the availability of jobs; being ethnicity often correlated with income and income with residence, even if residential choices were unconstrained by ethnic discriminatory rules, the different ethnic groups would not be randomly distributed among residences. The third source is spatial attraction. The Schelling (1971) model shows that when a household settles in a neighborhood, the neighborhood becomes more attractive to members of the household's own group and less attractive to members of other groups; Schelling demonstrates that even mild preferences for living with similar neighbors can be a strong determinant of residential segregation.

Mazza and Punzo (2016) propose the use of the inhomogeneous K-function (Baddeley et al., 2000) to study settlement patterns of groups of foreign immigrants. This approach allows assessing the effects of spatial attraction (or inhibition), while adjusting for the effects of spatial inhomogeneity.

Here, attention is focused on the analysis of the settlement patterns recently originated by different groups of immigrants in the city of Naples, Italy. Data at hand are addresses of households constituted by foreign immigrants, as recorded by the city register office of Naples at December 31st, 2013. Register data have been integrated within a geographical information system, and all the residential addresses were geocoded.

2 Methodology

2.1 Spatial heterogeneity and spatial dependence

The spatial distribution of household locations may be represented by a point pattern, i.e. a set of points in a map.

The simplest theoretical model for a spatial point pattern is that of complete spatial randomness (CSR), in which events follow a homogeneous Poisson process, i.e. the expected number of events occurring within a unitary region $u \in R$ follows a Poisson distribution, whose intensity $\lambda(u)$ is uniformly distributed over R; (Diggle, 2003). Furthermore, in CSR the outcome in one region of space has no influence on the outcome in other regions.

An inhomogeneous Poisson process exhibits more variation in the location of events than CSR, i.e. clustered patterns occur, with regions where $\lambda(u)$ is higher receiving a higher number of events. Clustered patterns may also arise from violation of second-order stationarity, in which the existence of one event increases the probability of the occurrence of other events in the neighborhood.

2.2 The inhomogeneous K-function

Ripley's K-function, usually denoted with $K(d)$, is a widely used technique to detect clustering (or inhibition) in point processes with constant intensity; at every spatial distance d, $\lambda K(d)$ is the expected number of additional points of the process $\mathbf{X}$ located in a circle b of radius d surrounding an arbitrary event. Formally

$$K(d) = \frac{1}{\lambda} \mathrm{E}\left[n(\mathbf{X} \cap b(u,d) \setminus \{u\}) \mid u \in \mathbf{X}\right].$$

Besag (1977) proposed a transformation of the K-function, defined as:

$$L(d) = \sqrt{\frac{K(d)}{\pi}} \tag{1}$$

Under the null hypothesis of absence of spatial dependence we have $L(d) = d$, making visual assessment much easier.

Baddeley *et al.* (2000) generalized Ripley's K-function to non-homogeneous point processes, by weigthing each point x_i by $w_i = 1/\lambda(x_i)$. The inhomogeneous K-function is defined as

$$K_{\mathrm{inhom}}(d) = \mathrm{E}\left[\sum_{x_j \in \mathbf{X}} \frac{1}{\lambda(x_j)} \mathbf{1}\left\{0 < \left\|u - x_j\right\| \leq d \,\middle|\, u \in \mathbf{X}\right\}\right] \tag{2}$$

where $\left\|u - x_j\right\|$ is the Euclidean distance between points u and x_j and $\mathbf{1}\{\ldots\}$ is the indicator function.

For estimating K_{inhom}, Baddeley and Turner (2000) proposed the estimator

$$\widehat{K}_{\mathrm{inhom}}(d) = \frac{1}{D} \sum_i \sum_{j \neq i} \frac{\mathbf{1}\left\{\left\|x_i - x_j\right\| \leq d\right\}}{\widehat{\lambda}(x_i)\widehat{\lambda}(x_j)} e(x_i, x_j, d) \tag{3}$$

where $e(x_i, x_j, d)$ is an edge correction weight, $\widehat{\lambda}(u)$ is an estimate of the intensity function $\lambda(u)$ and D is the total surface of the study area; for further details, see Baddeley (2010).

3 Foreign migration in the city of Naples

The immigrant presence is an evolutionary phenomenon because of the new arrivals and their demographic characteristics (such as origin country, age, sex, etc.) that continuously change the settlement and allocation of migrations. The existing scenario in the city of Naples is complex because of the temporal stratification of successive arrivals that are different according to their characteristics, contextual possibilities and migratory strategies (De Filippo and Strozza, 2015).

Data at hand come from the Naples Municipal Population Register. As all administrative sources, the Municipal Population Registers generally suffer from some discrepancies between the existing situation and the recorded one. In manner of fact, individuals may be present in the municipality's registers for administrative reasons even they are no (more) usually resident and at the same time other individuals are unable or unwilling to acquire the residence even they reside in the municipality of reference. Moreover, the indication of the place of residence could be fictitious or different from the existing one. However, we used the 2014 updated data of the Population Register of Naples Municipality. We assume they are robust (representing the existing situation), as they are revised by 2011 census and post-census adjustments, i.e. the corrections relating to people mistakenly not counted or counted more than once. Critical elements in specific cases remain anyway for example by district and by citizenship of residents. The comparison of Population Register with other administrative sources may for example bring out cases of people who might be present in the area and not in the register of residents, as well as people who are not in any other archive and it is likely that they do not reside on the territory. For example, the total number of Sri Lankan children in Population Register and in Schools' Registers is so different in Naples as to suggest they not only school leavers, but also there is a significant presence of young residents that spend only short periods in Naples to join to their parents during their holidays.

Table 1 reports the number and demographic characteristics of immigrants and households originated by immigrants, resident in the city of Naples and afferent to the top eight nationalities at 31.12.2013. According to the Italian Laws, regulating cities' population registers (art. 4 of Presidential Decree 223/1989), the household is a group of people linked by marriage, affinity, adoption, guardianship or affective bonds who live together. We consider single person households as well.

The first eight nationalities represent 69.3% of total immigrant population. They show the peculiarity of immigrant residents in Naples by ethnic group in respect both to the regional context and to the national context. The most numerous groups come from Sri-Lanka, Ukraine and China, while Moroccans and Albanians (respectively the second and the third most numerous nationalities in Italy) are not in the top eight nationalities. Demographic characteristics show important differences within the selected ethnic groups. Chinese have the highest quota of individuals in age 0-24 (32.8%), while the largest part of Ukrainians are aged 45+ (62.0%). The latter group presents the highest quota of women (83.7%) and a significant quota of separated/divorced/widowed individuals (22.3%). Pakistanis are mainly men (92.3%); Chinese and Sri-Lankans are mostly gender balanced (such groups have also the

highest mean number in household, respectively 2.7 and 2.1 components). Immigrants coming from Sri-Lanka are also married in the largest quota (61.1%). In the end, Philippines and Dominicans are the group with the highest quota of individuals resident in Naples for at least eleven years (respectively 39.9% and 28.6%), while the largest parts of Pakistanis and Chinese are resident since less than six years (respectively 75.7% and 63.1%).

In order to consider and separate the forces that affect residential ethnic segregation (Schelling, 1971), further analyses consider the workers' characteristics by ethnic groups. Using the available data of a recent sample survey conducted in 2013 within the regional project "Yalla" (POR FSE 2007-2013), we provide further information in Table 2 on immigrant workers in Naples. The survey interviewed 3,815 adult immigrants in Campania (803 in the city of Naples) and collected 72 questions on the demographic and social characteristics, life and integration conditions of immigrants coming from less developed countries and East-European countries (EU and extra-EU) who were present (resident and non-resident) at interview in the referent context. Data are pondered using "center sampling technique" (Baio *et al.*, 2011) and weighted in order to make the results in Table 2 representative of the observed collective.

Among the selected ethnicities, the highest quotas of employed people are observed among immigrants coming from Pakistan (93.1%), Ukraine (82.0%) and Sri-Lanka (80.6). The selected characteristics of occupation show an important heterogeneity among immigrant workers according to their ethnicities. Significant percentages of irregular employees characterize the occupation in Naples. Romanians have the highest quota of irregular jobs (52.1%). Pakistanis and Chinese have the highest quota of self-employed workers (respectively 51.8% and 33.9%) and the lowest quota of domestic employs (0.0% and 3.4%) together with Dominicans (7.7%). Such results show the persistence of ethnic specialization and segregation of immigrant in the labor market of Naples. In order to control such effect on residential allocation and the spatial inhomogeneity within the urban space, we consider the occupational ethnic segregation in the following analyses.

Table 1: Individual and households' characteristics of the main immigrant ethnicities in the city of Naples at 31.12.2013.

Characteristic		Sri-Lanka	Ukraine	China	Romania	Philippines	Poland	Pakistan	Dominican Republic
Age	0-24	24.5%	9.1%	32.8%	21.9%	23.2%	14.8%	12.2%	29.8%
	25-44	46.7%	28.9%	44.3%	54.9%	34.6%	56.0%	69.7%	41.6%
	45+	28.8%	62.0%	22.9%	23.2%	42.2%	29.2%	18.1%	28.6%
Sex	Men	54.3%	16.3%	52.8%	40.2%	40.1%	14.9%	92.3%	37.0%
	Women	45.7%	83.7%	47.2%	59.8%	59.9%	85.1%	7.7%	63.0%
Civil status	Single	37.9%	29.5%	53.7%	51.9%	46.7%	53.0%	55.0%	65.7%
	Married	61.1%	48.2%	45.3%	39.7%	51.7%	38.0%	44.6%	30.5%
	Other	1.0%	22.3%	1.0%	8.4%	1.6%	9.0%	0.4%	3.8%
Years of residence	0-5	58.6%	53.7%	63.1%	58.7%	36.8%	31.6%	75.7%	50.9%
in Naples	6-10	22.0%	37.8%	27.0%	39.3%	23.3%	46.2%	16.5%	20.5%
	11+	19.4%	8.5%	9.9%	2.0%	39.9%	22.2%	7.8%	28.6%
Number of individuals		10,795	7,850	3,602	2,011	1,825	1,294	1,028	976
% of tot. immigrant population		25.4%	18.5%	8.5%	4.7%	4.3%	3.0%	2.4%	2,30%
Number of househols		5,218	6,241	1,338	1,208	941	1,016	594	531
% of total immigrant households		19.9%	23.7%	5.1%	4.6%	3.6%	2.3%	2.0%	2.3%
Mean number in household		2,1	1,3	2,7	1,7	1,9	1,3	1,7	1,8

Source: Naples Population Register

Table 2: Workers' characteristics of the main immigrant ethnicities in the city of Naples.

Ethnicity	% of workers	Type of occupation		
		Irregular	Self-employed	Domestic
Sri Lanka	80.6	25.7	6.4	74.5
Ukraine	82.0	22.8	4.7	74.3
China	62.8	7.39	33.9	3.4
Romania	49.0	52.1	17.4	43.8
Philippines	76.8	14.4	0.0	74.7
Poland	74.6	40.5	0.0	67.7
Pakistan	93.1	40.8	51.8	0.0
Dominican Republic	69.9	21.1	0.0	7.7
Other	71.7	35.7	22.6	37.1
Total	74.7	28.2	13.6	55.0

Source: Yalla sample survey, 2013.

4 Migrants settlement patterns in the city of Naples

In this section we will estimate the intensity functions $\lambda_i(u)$, with $i = 1,\ldots,p$, related to immigrants of the $p = 8$ most numerous nationalities, as depicted in Fig. 1. Then, the inhomogeneous K-function will be used to describe and compare their settlement patterns.

In order to avoid the risk of mixing up spatial inhomogeneity and spatial attraction, we follow a modified version of the *case–control* approach described in Arbia *et al.* (2012). It aims at checking whether immigrants of nationality i have a stronger tendency to live together than what would be predicted by the environmental influences estimated on *other* nationalities who are assumed to share the same influence from spatial inhomogeneity. In the present context, the point pattern of cases is made up by the households belonging to the specific nationality i that we are researching, while the control reference point pattern derives from all the households belonging to the same occupational group as nationality i but with the exception of i itself.

Two occupational groups are considered, "domestic workers" and "others"; common workplaces for domestic workers are found in wealthier residential neighborhoods, while the group "others" consists for the most part of retailers, peddlers and other vendors who favor other locations, mostly close to the city center. The domestic workers group is made up of Sri Lanka, Ukraine, Romania, Philippines, Poland; the group others consists of China, Pakistan and Dominican Republic.

The intensity function $\lambda_i(u)$ is estimated non-parametrically; Fig. 2 shows the spatial distribution of $\ln(\widehat{\lambda}_i(u)/\widehat{\lambda}_i)$; we use relative intensities to allow the compar-

ison among the different nationalities. Furthermore, the log scale is used to make fractional changes equivalent.

The monocentric picture of all the considered nationalities represents the first interesting result of the analysis. Such result supports the output outlined by Benassi *et al.* (2014) about the increasing presence of immigrants in the city center and in the coastal areas of the city. All nationalities share a spatial trend, with higher values in the more central parts of the city and lower in the more peripheral areas. However, this spatial trend is much stronger for non domestic workers. As quoted by Ammaturo *et al.* (2010), Chinese, Pakistani, and Dominicans distribute among Naples' areas differently in respect to the natives (see Fig. 1). In particular, Chinese, that represent the third immigrant presence in Naples by residents, concentrate in the Central-East areas and, in particular in San Lorenzo, with a significant localization in the industrial area and the nearby (Vicaria and Mercato). Conversely, ethnic groups, that have the highest quota of domestic workers, reside in the proximity of the households where they offer their services. Immigrants from Sri Lanka locate in the areas of Stella, Avvocata and Montecalvario. The Ukrainians are present mainly in the residential areas of Vomero.

Having obtained the estimation $\widehat{\lambda}_i(\lambda)$, $i,\ldots,n$, for the $n = 8$ nationalities considered, we can now compute the estimates for the inhomogeneous L-function $\widehat{L}_i(d)$ at various distances d.

It should be noted that $\widehat{L}_i(d)$ accounts for the effects of spatial attraction among households belonging to the same nationality i, that is the spatial concentration of households remaining after adjusting for the effects of spatial inhomogeneities estimated by $\widehat{\lambda}_i$. So, higher values of $\widehat{L}_i(d)$ imply higher residual spatial concentration, which do not necessarily correspond to higher overall levels of spatial segregation.

Plots in Fig. 3 show the behavior of $\widehat{L}_i(d)$. Distances d are expressed in meters. Plots also report the confidence envelopes referred to the null hypothesis of absence of interaction, at a significance level $\alpha = 0.01$ and based on 999 Monte Carlo simulations. Distances corresponding to the peaks of $\widehat{L}_i(d)$ outside the envelopes are those at which there is significant spatial concentration or dispersion.

Overall, significantly high levels of spatial attraction have been observed for all the nationalities researched at almost all the distances considered. However, Dominicans, Ukrainians, Polishes, and Romanians showed lower values, which for Polishes and Romanians lay within the confidence envelopes at distances over 2.5 Km. Note that these nationalities are characterized by a higher percentage of females. On the other end, Chinese, Pakistans, Philippines, and Sri Lankans reported higher levels of spatial attraction. Further studies are needed to investigate on the reasons underling these behaviors. One hypothesis is that nationalities which reported the lower values of spatial attraction might be more often involved in working as caregivers for the elders, and so have to reside within the same house of the person they attend to. Another hypothesis may be related to a differentiation in migration patterns, with nationalities that experienced stronger chain migrations or more family reunifications exhibiting a stronger spatial attraction.

5 Conclusions

This paper focused on measuring segregation due to spatial attraction among foreign migrants holding the same nationality within the city of Naples (Italy). As in Mazza and Punzo (2016), we used the inhomogeneous *L*-function (Baddeley and Turner, 2000) for assessing the residential clustering due to attraction among individuals, while adjusting for the effects of inhomogeneity within the study region.

To avoid the risk of mixing up spatial inhomogeneity and spatial attraction, we applied the *case–control design* used in Arbia *et al.* (2012). This framework allowed to check whether immigrants of each nationality had a stronger tendency to live together than what was predicted by the environmental influences estimated on immigrants of other nationalities who were assumed to share the same influence from spatial inhomogeneity. To this end, two groups, based on a work specialization resulting from previous studies, were considered: "domestic workers", made up of Sri Lanka, Ukraine, Romania, Philippines, Poland, and "others", made up of China, Pakistan and Dominican Republic.

Monte Carlo simulations have been used to build confidence envelopes for the null hypothesis of absence of spatial attraction. All nationalities exhibited significant spatial attraction at all considered distances, except for Romania and Poland. However, spatial attraction resulted much stronger for immigrants from Pakistan, China, and Sri Lanka. In future studies we propose to investigate on the reasons underling the observed different behaviors.

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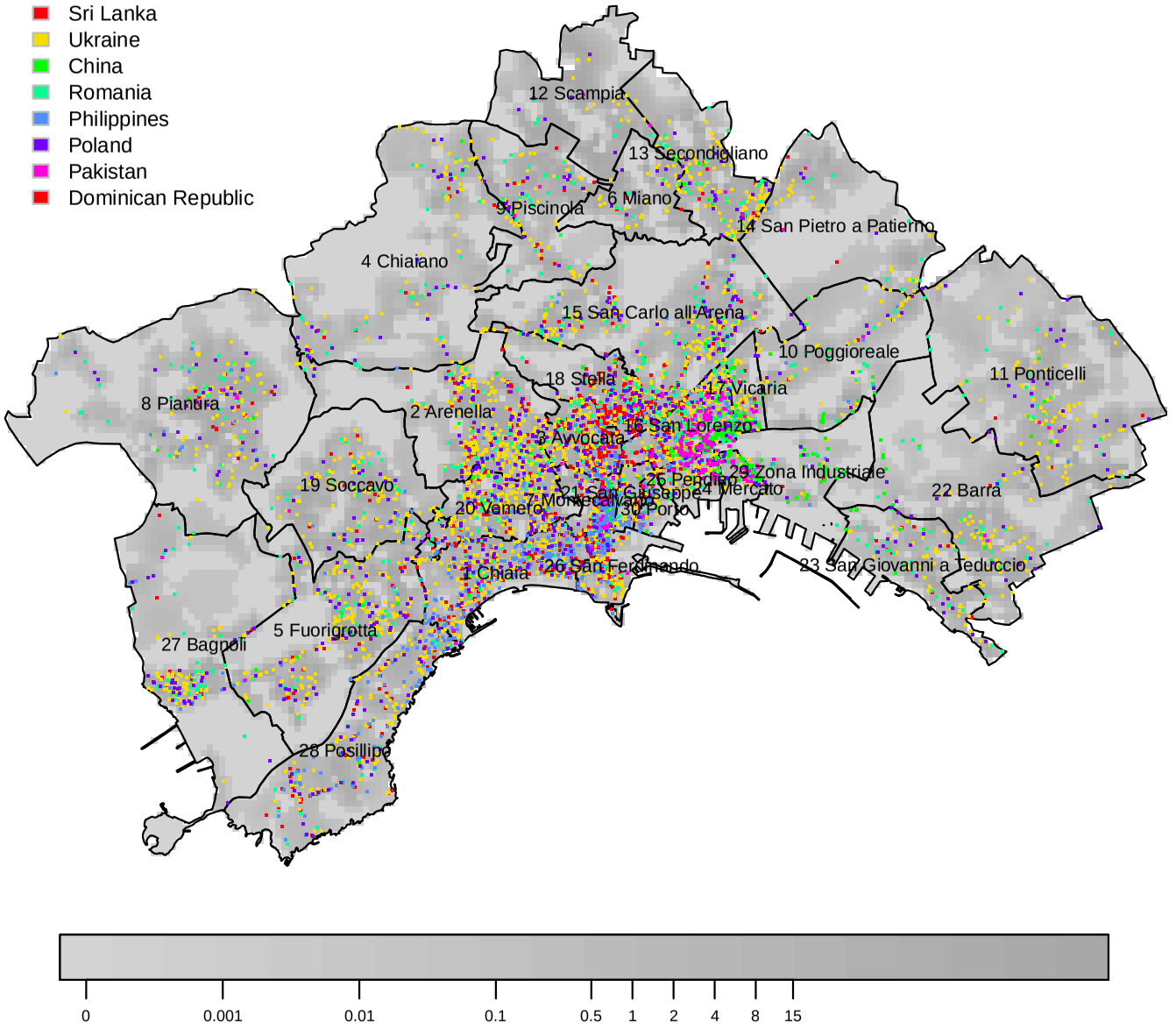
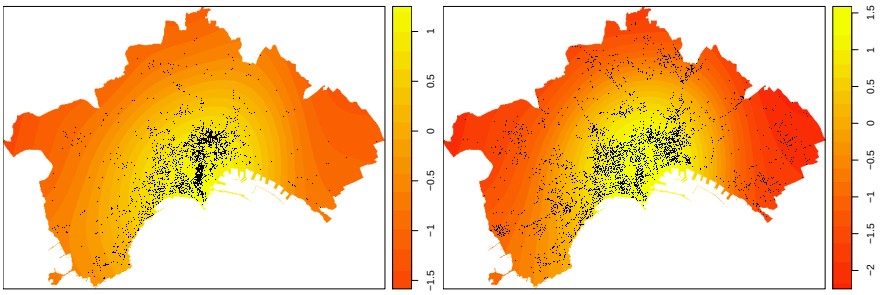
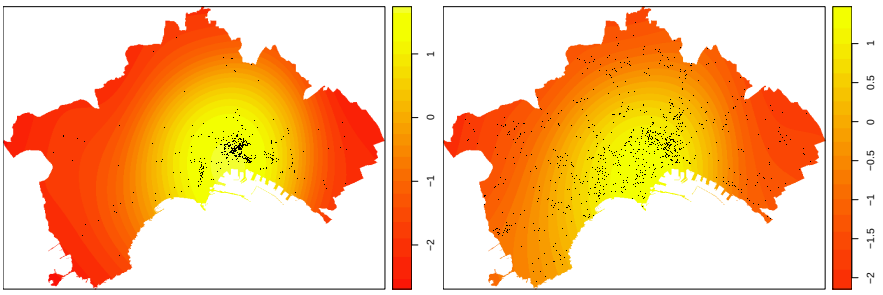


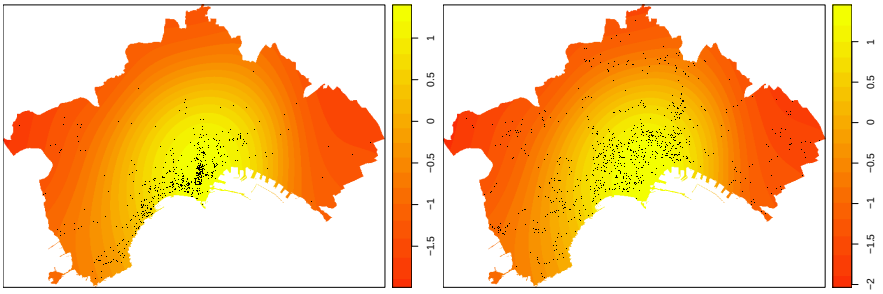
Fig. 1: Foreign immigrants' households locations for the top eight nationalities in the city of Naples at December 31st, 2013 (source: Naples Population Register). In the background, smooth pycnophylactic interpolation (Tobler, 1979) of population counts for census tracts (2011 General Population Census, `http://dawinci.istat.it/`).



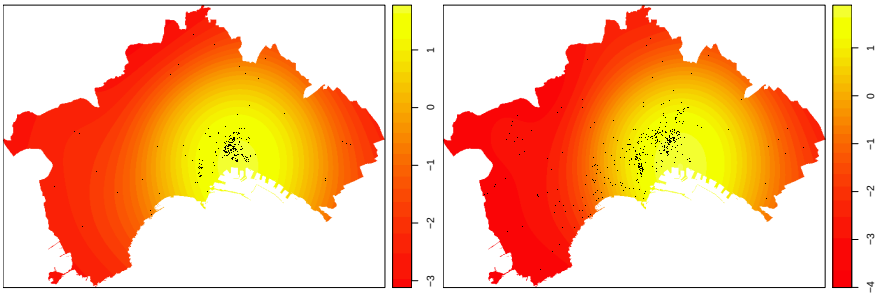
(a) Sri Lanka (b) Ukraine



(c) China (d) Romania

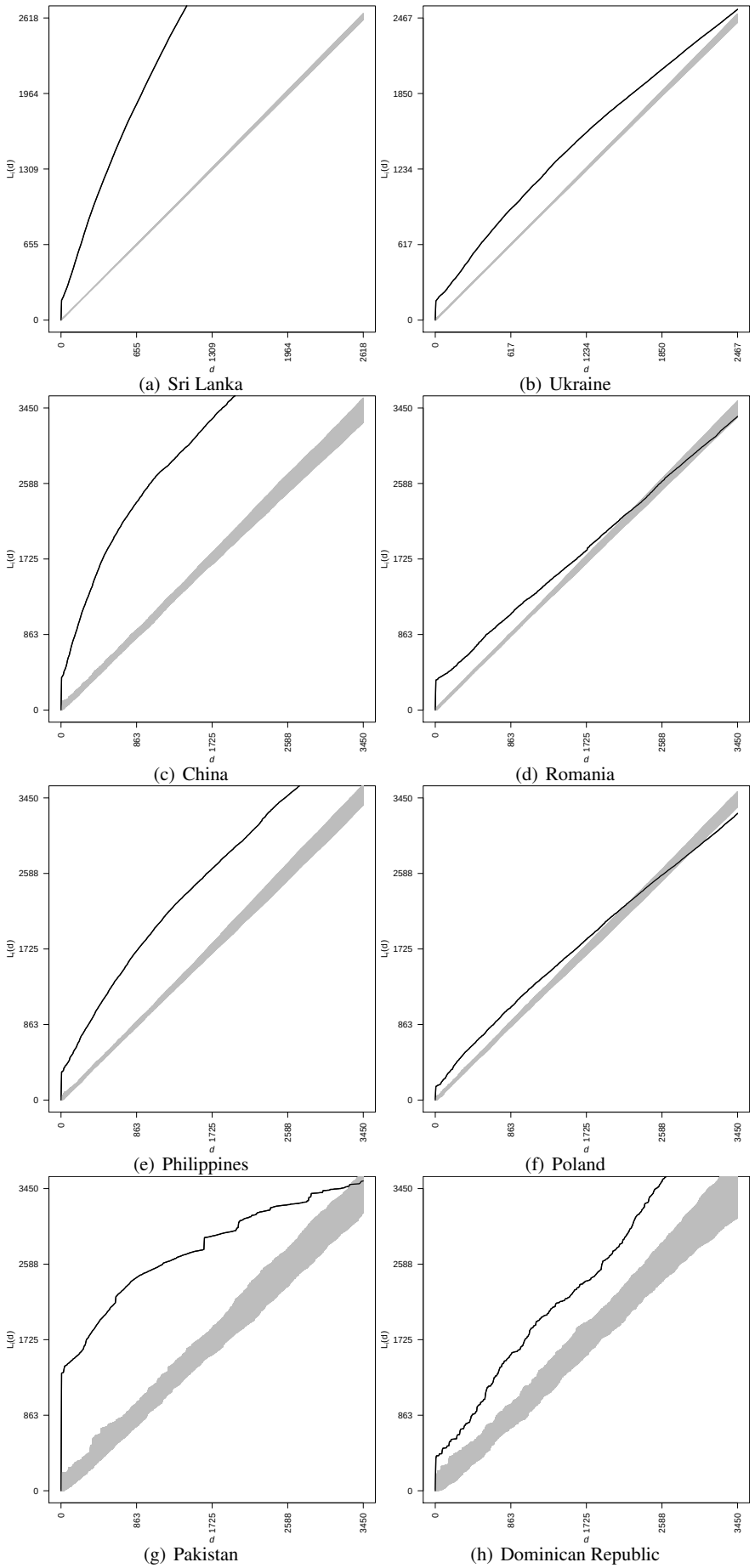


(e) Philippines (f) Poland



(g) Pakistan (h) Dominican Republic

Fig. 2: Spatial distribution of the estimated log relative intensities $\ln(\hat{\lambda}_i(u)/\hat{\lambda}_i)$ for the different nationalities.



(a) Sri Lanka (b) Ukraine

(c) China (d) Romania

(e) Philippines (f) Poland

(g) Pakistan (h) Dominican Republic

Fig. 3: Estimated inhomogeneous L-functions (solid black lines) and the corresponding 99% confidence envelopes (shaded area) under the null hypothesis of absence of interaction, based on 999 Monte Carlo simulations. Distances d are expressed in meters.