Examining the Patterns of Foreign Migration to Denmark

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Abstract

Do people, who come from the same country, i.e., share a country of origin, tend to live closer together? Are there patterns of foreign migration in Denmark? The present study investigates migration data to Denmark over the last few years, namely, 2020-2023. Moran's I test with Monte Carlo simulations is used to investigate whether the total numbers of newcomers across municipalities cluster; whether people who come from the same country of origin, such as Ukraine, Romania, Germany, Poland, India, China, USA, Eritrea and Australia tend to live closer. Spatial autocorrelation analysis also considers different definitions of neighborhoods, namely, neighbors, defined by contiguity, distance band of 25km and 50km, and k-nearest neighbors (k = 3). Significant spatial autocorrelation was found for migration data of Germany, Romania, India, China, USA, and Australia; however, result was found to be dependent on the neighborhood specification. Although results might signal the phenomenon of chain migration, other possible factors that might influence migration behavior should be considered in the future studies.

Keywords: *chain migration, spatial autocorrelation, Moran's I.*

Introduction

Denmark has experienced an increasing number of migration inflows since the very end of World War II (Matthiessen, 2009). It has started with refugee migration, who came to Denmark from different parts of the world (Wadensjö, 2000). Subsequently, Denmark has also became a country for labor immigrants and people, who join their family members who have already migrated to Denmark beforehand. Since then, Denmark is attracting more and more people every year, with majority of foreigners coming for work, family reunification and studying purposes (*Governance of Migrant Integration in Denmark | European Website on Integration*, 2024).

So far it is clear that migration can happen for numerous reasons. On one hand, migration can be systematic – for reasons such as work or humanitarian needs; on the other hand, it could be due to personal reasons, such as relationships with the family members or friends. The latter is usually called *chain migration*, and primary reason of such migration are "social relationships" with the people who have immigrated previously (MacDonald & MacDonald, 1964). Is chain migration a phenomenon that is present nowadays in Denmark? Do people, who come from the same country, tend to live closer to one another?

The present study is designed to explore foreign immigration to Denmark during the last few years, namely, from 2020 to 2023. The goal is to investigate whether immigration happens in patterns and whether people who share the same country of origin tend to live closer together.

Data acquisition and processing

Spatial data

The spatial data was acquired from the Global Administrative Areas (GADM) database[1] and was loaded to R (R Core Team, 2024). This data contains administrative boundaries, represented as multipolygons, for municipalities in Denmark. This geographic information was projected to the *EPSG:25832 (ETRS89/UTM zone 32N)* Coordinate Reference System. Data downloading instructions can be found in *Appendix 1*.

Statistical data

The immigration data was obtained from Statistics Denmark (www.dst.dk) for years from 2020 to 2023. To combine this with spatial data, statistical information was aggregated by

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[1] https://gadm.org/index.html

municipalities. The acquired dataset includes information on the country of origin, the municipality, and the number of people who have immigrated to Denmark. The steps of data preprocessing and how it could be downloaded can be found in *Appendix 1*.

Methods

Software Framework

The code was developed and run on MacBook Pro, 2020, macOS Sonoma 14.2.1 version. R Studio version of 2024.04.1 + 748 and R version 4.4.0 was used to perform the present analysis. *Table 1* contains the main packages, that are required to run the code. More information on software and data metadata can be found in *Appendix 6*.

Package	Version
tidyverse	2.0.0
sf	1.0.16
ggplot2	3.5.1
dplyr	1.1.4
tmap	3.3.4
cowplot	1.1.3
raster	3.6.26
cartogram	0.3.0
spdep	1.3.3
knitr	1.46

Table 1: Main packages with their versions, that should be installed to run the code.

Data preparation

Preprocessed data was used to plot the total number of newcomers across municipalities (*Fig.1*) and find 5 municipalities with greatest numbers of newcomers for years 2020 to 2023 (*Appendix 2*). Throughout this period, top 5 municipalities remained the same: Copenhagen, Aarhus, Aalborg, Odense, and Frederiksberg. Subsequently, each country of origin was assigned to a broader group of classification: America, Europe, Asia, Africa, and Oceania. This allowed to calculate the percentage of people who migrate to Denmark from each region (*Appendix 3*). Around 71% of newcomers came from Europe, with most people from Ukraine, Romania, Germany, and Poland. Approximately 19% came from Asia, 7% from America, 2% from Africa and 0.6% from Oceania region. India, China, USA, Eritrea, and Australia were found to be the newcomers' top countries of origin (from each region) during 2020-2023. Due to timing constraints, the analysis will be carried out for these 9 countries.
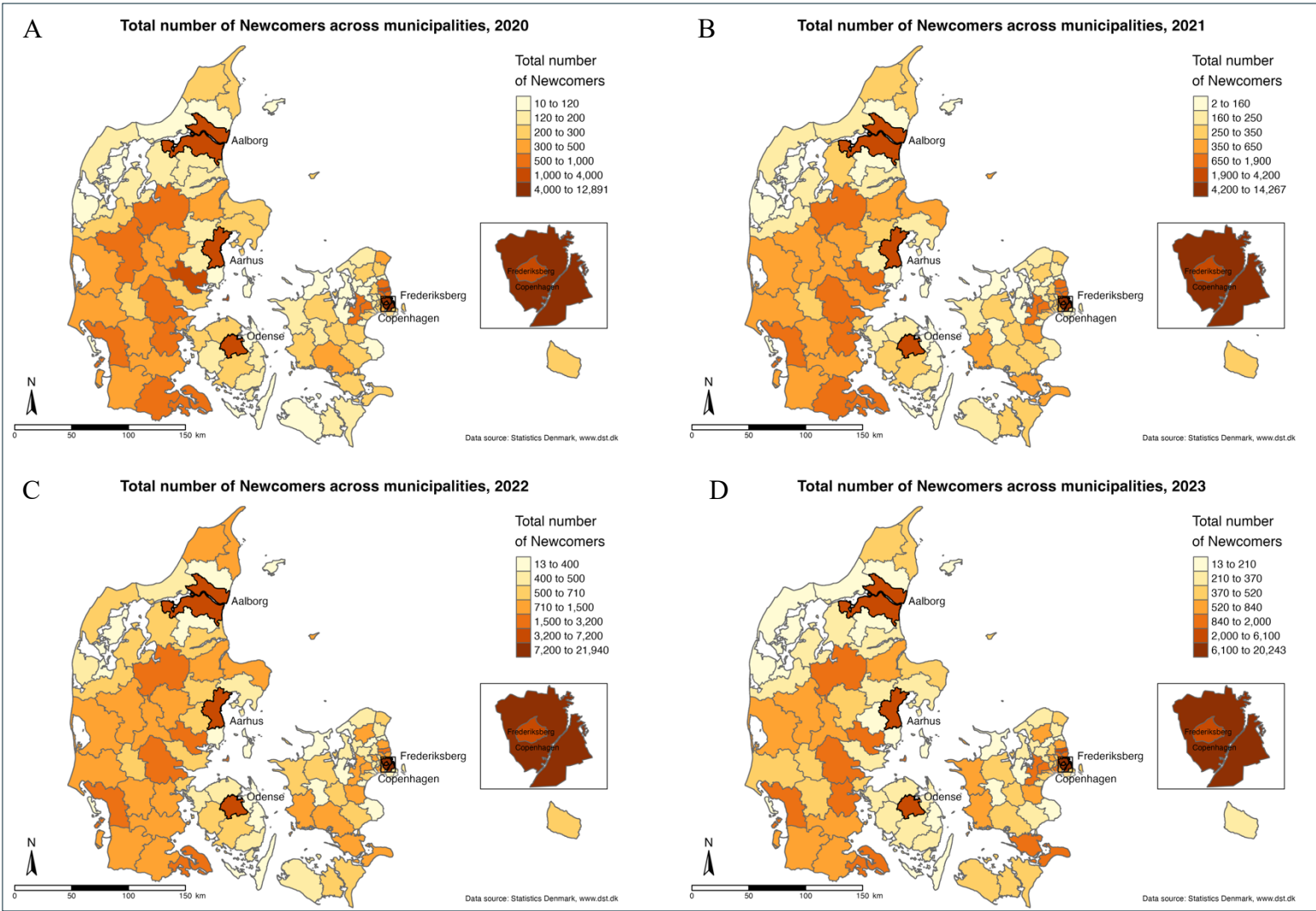
Figure 1: Total number of newcomers across municipalities in 2020 (A), 2021 (B), 2022 (C) and 2023 (D). Top 5 municipalities with the greatest number of newcomers are highlighted in black. Since immigration data is highly skewed, the last range of the legend contains only one value – the total number of newcomers in Copenhagen. See Appendix 2 for exact numbers.

Moran's I: Spatial Autocorrelation test

To investigate if people, who come to Denmark from the same country of origin, tend to reside closer together, Moran's I test with Monte Carlo simulations was performed (Waldhör, 1996). This test provides the Moran's I statistic – a metric which represents a correlation coefficient for the relationship among the total number of newcomers from country X to municipality Y, and a total number of newcomers from country X in neighboring municipalities. Moreover, the test provides a *p-value*, which refers to how significant the latter metric is (Gimond, 2023).

Since the spatial autocorrelation test computes a coefficient of correlation between one value of the variable and values of neighboring locations, it is important to define what these neighbors are. Four neighborhoods (further, NBs) were defined to investigate whether the clusters

of different NB definitions can affect the results, namely, NBs were defined by contiguity, distance band of 25 km and 50 km, and k-nearest (k=3) neighbors (*see Appendix 4 for plots per country*). The test was performed by employing '*moran.mc( )*' function with 999 Monte Carlo iterations from *spdep* package (Bivand R, Wong D, 2018).

Results

Moran's I test with Monte Carlo simulations was performed on immigration data from 2020 to 2023 for the following newcomers' countries of origin: Ukraine, Romania, Germany, Poland, India, China, USA, Eritrea, and Australia. All the results for different NB definitions are shown in *Table 2*.

Country of Origin	Type of NB	Moran's I statistic	p-value
Ukraine	Contiguous	-0.02	0.56
	Distance of 25 km	-0.06	0.87
	Distance of 50 km	-0.01	0.51
	K-nearest neighbors, k = 3	0	0.31
Romania	Contiguous	0.05	0.15
	Distance of 25 km	-0.01	0.44
	Distance of 50 km	0.11	0.01
	K-nearest neighbors, k = 3	0	0.42
Germany	Contiguous	0.13	0.03
	Distance of 25 km	-0.02	0.53
	Distance of 50 km	0.05	0.03
	K-nearest neighbors, k = 3	0.15	0.02
Poland	Contiguous	-0.04	0.69
	Distance of 25 km	-0.06	0.84
	Distance of 50 km	0	0.39
	K-nearest neighbors, k = 3	-0.06	0.81
India	Contiguous	0	0.32
	Distance of 25 km	0.02	0.07
	Distance of 50 km	0	0.14
	K-nearest neighbors, k = 3	0.12	0.01
China	Contiguous	0.02	0.13
	Distance of 25 km	0	0.19
	Distance of 50 km	0	0.27
	K-nearest neighbors, k = 3	0.11	0.04
USA	Contiguous	-0.01	0.33
	Distance of 25 km	0	0.2
	Distance of 50 km	0	0.1
	K-nearest neighbors, k = 3	0.09	0.001
Eritrea	Contiguous	-0.04	0.64
	Distance of 25 km	-0.02	0.5
	Distance of 50 km	-0.02	0.5
	K-nearest neighbors, k = 3	0.01	0.35
Australia	Contiguous	-0.02	0.61
	Distance of 25 km	0	0.31
	Distance of 50 km	0	0.26
	K-nearest neighbors, k = 3	0.01	0.03

Table 2: Results of Moran's I test with Monte Carlo simulations.

With regards to people from Ukraine, Poland and Eritrea, no significant spatial autocorrelation was found, indicating that total number of newcomers across municipalities are not spatially clustered. In terms of people from Romania, significant spatial autocorrelation was found only when neighbors are defined by distance band of 50km, *Moran's I: 0.11, p-value = 0.01*. Significant spatial autocorrelation clusters for Germany's migration data were identified when neighbors are defined by 50km distance (*Moran's I: ~0.05, p-value: ~0.03*), queen contiguity (*Moran's I: ~0.13, p-value: ~0.03*) and k=3 nearest neighbors (*Moran's I: ~0.15, p-value: ~0.02*).

Significant spatial autocorrelation clusters were captured only with k-nearest neighbors (k=3) for newcomers from India (*Moran's I: ~0.12, p-value: ~0.01*), China (*Moran's I: ~0.11, p-value: ~0.04*), USA (*Moran's I: ~0.09, p-value: 0.001*), and Australia (*Moran's I: ~0.01, p-value: ~0.03*).

Discussion

Spatial autocorrelation analysis was performed to investigate whether people who come from the same country to Denmark, tend to settle down closer together. *Appendix 5* contains the plots of total number of newcomers across municipalities for each country that was analyzed.

The largest group of newcomers throughout the years of 2020-2023 were found to be the ones from Ukraine. However, a great number of Ukrainians have come to Denmark as refugees and therefore were distributed across all municipalities (Bang Carlsen et al., 2023). The latter might be considered as one of the reasons why no spatial autocorrelation/no patterns of migration have been found. The same result was found for migration data of people from Poland and Eritrea, and although chain migration could be an occurring phenomenon, spatial analysis did not reveal any significant clustering in total numbers of migration across municipalities.

With regards to the rest of the countries, results of spatial autocorrelation analyses were found to be sensitive to the NB definition. In terms of migration from Germany, the absence of significant spatial autocorrelation for NBs defined by 25km distance band might indicate that this specific distance is either not sufficient in capturing clustered regions, or factors, which influence migration to these regions, are not constrained within the distance of 25km. Patterns of chain migration, or spatial clustering, were found for other definitions of NBs, and therefore factors influencing migration to the regions that are immediate neighbors (contiguous), close together (k-nearest neighbors, k=3) and within a 50km distance band (but greater than 25km

radius) do exist. For instance, it is clear from the *Fig. 3*, *Appendix 5* that a great part of people from Germany have settled down in municipalities close to the Germany's boarder.

Migration data of people from Romania was found to cluster as well, however, only when the NBs are defined by a 50km distance band. As similarity in migration patterns is significant over large NBs rather than small ones, it might mean that people from Romania tend to spread across broad regions and be a part of communities which cover greater areas. However, it is also likely that newcomers are more spread out due to employment, housing, or other factors. People from India, China, USA, and Australia were found to cluster close together only when NBs are defined as k-nearest neighbors, k=3, suggesting that newcomers tend to migrate to municipalities that are very close together.

Critical evaluation and limitations

Although for most of the chosen countries' spatial autocorrelation in terms of total numbers of newcomers across municipalities has been found significant, and possibly indicates a phenomenon of chain migration, it is likely that migration is driven not only by social networks, but also by employment opportunities, housing prices, etc. Moreover, municipalities are managing tasks such as "active employment efforts" and "integration of language education", which could also influence where newcomers decide to settle down (Moreno, 2012, p. 136). Finally, in the study by Parreño-Castellano et al. (2021), a time period of a decade has been investigated to see whether immigration is happening in patterns. It might be that exploring migration data during 2020-2023 period was not enough in capturing accurate patters of immigration.

It is also important to consider the actual quality of the statistical data, which was used in the analysis. Although the analysis was performed based on the newcomers' country of origin, it is also possible that people, before migration, have been living in another country for great part of their lives, and therefore, considering data such as "country of last residence", rather than "country of origin" might yield to different patterns of migration.

Future research should take these considerations into account when analyzing foreign migration patterns to Denmark.

Conclusion

The present study has employed Moran's I test with Monte Carlo simulations to investigate patterns of foreign migration to Denmark. Due to time constraints, the analysis has been carried out only for immigration data from the countries with greatest total numbers of newcomers

across regions of Europe, Asia, America, Africa, and Oceania. Spatial autocorrelation analysis has revealed that the numbers of people from Germany, Romania, India, China, USA, and Australia tend to cluster together, meaning that newcomers from such countries tend to settle down in patterns. However, different types of NBs clusters revealed the importance of NBs' specifications in capturing significant spatial autocorrelation. Although newcomers from the same country of origin might be coming to Denmark due to chain migration, future studies need to take more factors into consideration when evaluating whether immigration is happening due to chain migration, or people, coming from the same culture, tend to settle down in certain locations due to other spatial factors.

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