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Determinants of migration and location choice of individuals in Brussels and its commuter zone

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A. Abstract

This research investigates the attractiveness of different municipalities in the commuter zone of Brussels. Specifically, the explanatory factors for the migration and location decisions of the population in Brussels and its commuter zone are examined. The expectation is that people locate themselves based upon pull factors such as employment opportunities, transport connectivity and the presence of push factors such as high crime rates. This is tested with a dataset containing cross-sectional data on all 118 municipalities constituting the Brussels Capital Region (BCR) and its commuter zone. This data is extracted from the Belgian, Walloon, Flemish and Brussels statistical offices STATBEL and geodatabases, containing information on all the hypothesized explanatory factors. Applying an ordinary least squares regression, it follows that the local employment opportunities and connectivity by public transport are determinant in the relocation of individuals. Moreover, high-income and high-age groups are more sensitive to factors such as crime, whereas others are more sensitive to the employment opportunities reigning in specific municipalities. This is largely in line with pre-existing research in this field and case studies led in other cities.

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Section 1: Introduction

In the last few decades, many parts of our planet have witnessed a rapid urbanization taking place. 55 per cent of the world population currently live in cities – and by 2050, this proportion is expected to reach 68 per cent (United Nations, 2019). As populations keep settling down in a dense areas, certain cities have to make a significant effort to tackle hazards such as the highly concentrated volumes of automobile exhaust conquering many cities (National Geographic, 2019).

However, studies have shown that when these hazards are concentrated in a dense space, they are easier to handle than when they are spread out (Kahn, 2006). In the past few decades, many cities have lost their compact structure, as affluent inhabitants have sought to eschew the urban squalor and settled in suburbs instead, hoping to find more space and safety (Frumkin, 2002). As a result, many cities now witness more traffic between its core and the suburbs – and as the periphery keeps spreading, more and more people commute longer distances. Automobile exhausts are now present in a larger area than ever before and their total volume has risen even further.

While this phenomenon is more accentuated in countries like the United States, there are also numerous European cities demonstrating a similar pattern: In fact, this trend has been visible in most medium-sized European cities since the late 1960s and it is barely slowing down: In a study led by the European Environmental Agency (2016) results have shown that urban sprawl has continuously grown in cities in all 27 EU member states.

One of these cities is the capital of Belgium, Brussels. Since the late 1960s, a large proportion of its inhabitants migrated to suburban neighborhoods seeking for a better quality of life (Poelmans & Van Rompaey, 2009). These neighborhoods are generally safer, quieter, greener than the central neighborhoods and dispose over various amenities. As the demand for the suburbs kept rising, an urban sprawl arose, causing formerly pristine lands to evolve into built-up areas. When an urban sprawl occurs, natural areas are divided into smaller patches. As a result, valuable habitats and ecosystems are put into danger and the local wildlife population is exposed to isolation, conducing to a reduced variability in their habitat structure (Fischer et al., 2006).

Moreover, the interaction between the suburban high-capital workers and the inner-city population has decreased to a further extent, engendering a deeper polarization of society. Firms have followed the lead of the emigrated high-capital population, whereby some of the most central neighborhoods of Brussels such as Molenbeek and Saint-Josse have the highest unemployment rates across the whole country (STATBEL, 2020). Furthermore, sprawl opponents consider this urban phenomenon as a burden to the social capital of cities: As people reside further away from each other, linkages between neighbors are undermined as people are less likely to bump into each other and devote a larger share of their time to transportation, diverting their time away from social activities (Nguyen, 2010).

However, it has to be noted that certain municipalities in the Brussels Capital Region (BCR) did manage to retain their population, possibly improving the ecological footprint of the region as a whole. Especially since the 1990s, specific urban municipalities have – like in many other cities in the industrialized world – experienced a significant revival, indicated by a positive population growth. Meanwhile, other neighborhoods have not been able to compete with the quality of life provided in the periphery. Therefore, in order to determine the reasons for the location and relocation across the different municipalities, the following research question has been formulated:

"What determines the migration and location choices of individuals across Brussels and its commuter zone?"

The ultimate goal of this research is to identify the economic drivers and other motives which determine the relocation patterns in Brussels and its commuter zone. The results are of a particular social relevance as they might stand in good stead for municipalities which try to reattract specific population segments and to counter harmful urban phenomena such as the sprawl across the commuter zone of Brussels. Moreover, the focus lies on the entire commuter zone of Brussels, unlike previous studies on the mobility of the local population, which have limited the metropolitan area of Brussels to a smaller area, leaving behind numerous municipalities where more than 15 per cent of the population work and commute to Brussels on a daily basis.

This research is organized as follows. First, a literature review will be provided to present all the necessary insights into the drivers of relocation of individuals between different municipalities and on the metropolitan area of Brussels (section 2). In section 3, the relevant data will be presented. In section 4, the statistical methods to answer the research question will be presented. In section 5, some first descriptive statistics on the relocation of individuals will be provided. Finally, in section 6, the hypothesized explanatory factors will be tested before proceeding to a conclusion on the research and comparing it to the reviewed literature.

Section 2: Literature Review

2.1. Livability

Livability is a term used by politicians and economist to measure the quality of life in a given city or region. Several researchers consequently sought to measure which cities or regions provide the best opportunities for a prosperous, healthy and safe life in the years ahead. However, the methods employed differ vastly from case to case. Some methods are based on purely objective dimensions, whereas others include highly subjective dimensions such as “life satisfaction”, which is for example implemented in the Economist Intelligence Unit’s “Where-to-be-born index” (The Economist, 2012). However, when applying a more objective and quantifiable approach, for example by measuring the impact of a plethora of possible explanatory factors on the population growth - or the demand for housing - across different cities, one can discover which characteristics are considered as desirable for a municipality. Some studies of this kind have shown that cities which are better able to exploit their productivity advantages are more likely to thrive. However, in the recent years, there has been an emerging number of papers considering the consumption advantages of cities as conducive to their growth.

2.1.1. Does a city grow due to its productivity advantages?

Historically, the productivity advantages that firms get exploit in certain cities, have been considered as the main factor to dampen emigration and to boost immigration. Duranton and Puga (2003) divide these productivity advantages into three types: sharing, pooling and learning. “Sharing” refers to the phenomenon where firms share their inputs or infrastructure such as a highway or an airport. “Matching” refers to the situation where firms and workers concentrate in the same city such that they are more easily matched. Finally, “learning” implies that certain cities give rise to a considerable spillover of information and knowledge being shared from firm to firm, and from employee to employee. Empirical research has further proven the positive association between the productivity advantages and population growth: Alperovich et al. (1977) found a positive relationship between job creation and the cities’ number of inhabitants. Pissarides and McMaster (1990) also found that changes in regional wage differentials and unemployment disparities have a positive relationship with population growth.

2.1.2. Does a city grow due to its consumption advantages?

Glaeser, Kolko and Saiz (2001) acknowledge that cities have certain productivity advantages but assert that demand for cities increases for reasons beyond rising wages, namely the consumption advantages certain cities dispose of. As firms have become increasingly mobile, they are now better able to follow the skilled employees. So, employees often do not seek to live high wage cities anymore, but firms locate themselves in cities with a high capital labour pool instead. Therefore, the success of cities now relies more on the city's consumption facilities. Workers locate in cities with a high variety of amenities like shops, restaurants, schools, etc. Their empirical research confirms their arguments, as they find that high amenity cities grow faster than low amenity cities. Urban rents also grew faster than urban wages, which suggests that there is an increasing demand for urban environments overall.

In addition to the urban character of certain municipalities, several first and second nature amenities have been considered as crucial to attract labour migration. Among the first nature amenities, desirable natural characteristics such as a pleasant climate or a picturesque landscape have been cited (Glaeser & Shapiro, 2001). Second nature amenities that fall into this category are facilities such as public infrastructure (Alperovich et al., 1977), well-functioning healthcare facilities (Porell, 2006) and the presence of a well-functioning transportation network (Duranton, 2012).

It has to be noted, however, that the consumption advantages are often intertwined with the productivity advantages. For example, Glaeser (2001) shows that skilled workers are more likely to settle down in the proximity of many consumption facilities, whereas Shapiro (2006) found that a high percentage of skilled workers encourages the opening of consumption facilities. Hence, many of these findings are subject to reverse causality.

Finally, low living costs are an ambiguous dimension to measure the city's attractiveness, because its housing prices also mirror its life quality. If a city gains in amenities, the real estate market will internalize the increasing life quality and will adjust the prices accordingly. Hence, "one person's amenity is often the next person's inconvenience" (Storper, 2006). However, the difference in housing price changes across different municipalities can serve as an indicator showing whether new amenities attract new inhabitants. Debrezion et al. (2006), for example, found that dwellings located near a railway station are on average 25% more expensive than dwellings more than 15 away. On the other hand, there is a positive relationship between distance to railway and housing prices, i.e. the proximity of a railway is a negative externality, which is most likely due to the noise effects.

2.1.3. Income-specific preferences

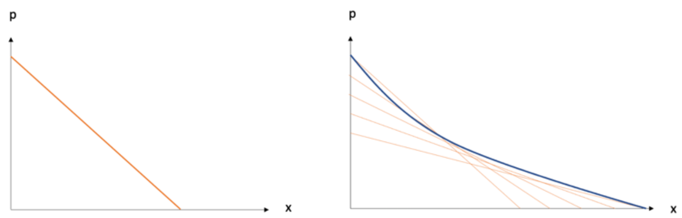
The extent to which specific factors influence the relocation of individuals varies across different income groups. This is because specific income groups might have different priorities than lower or higher earning population segments. The high earners might for example be more attracted by the municipalities with a high density of cultural institutions and shopping facilities, whereas the low earners might be more focused on positioning themselves in the proximity of their basic needs such as a food market.

2.1.3.1. Monocentric model and extension for income variation

An attempt to explain the distribution of people and housing prices across cities was made in the 1960s and 1970s, through the work of Alonso and Mills (Alonso, 1964 & Mills, 1972). In their monocentric city model, every household seeks to maximize its Cobb-Douglas utility function $U = c^{1-\alpha}q^{\alpha}$ with regards to its budget constraint $y = c + pq + tx$ (whereby c denotes the consumption of a generic good, q the consumption of a living area, p the price per living area, t the transportation costs per distance and x the distance from the CBD where all households are assumed to commute to).

The expected outcome under this model is that the renters swap their living areas up until the natural equilibrium, when both the landlord and the renter maximize their utility: The landlords rent out the living area to their highest bidder (hence the landlords cannot improve their utility by finding a new renter) and the renters rent the optimal location (hence the renters cannot improve their utility by moving). After computing the utility-maximizing consumptions of c* and q*, we get the price elasticity of distance: $\frac{dp}{dx}\frac{x}{p} = \frac{1}{\alpha}\frac{tx}{y-tx}$, which serves as a slope in the following set of bid-rent curves:

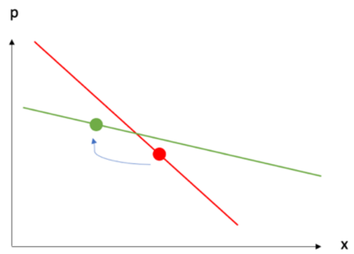
Figure 1. Individual and aggregate bid rent curve



Note: Y-axis depicts the price per unit of living area, x-axis depicts the distance from CBD. Orange curve depicts individual bid rent curve, thick blue curve depicts aggregate bid rent curve

However, the monocentric city model departs from the assumption that all households are equally productive and earn the same wage y. But people differ in terms of income, especially in cities, where inequalities are often higher than in rural areas. Therefore, the monocentric city model undergoes an extension. The price elasticity of demand is now denoted as follows, whereby i is "rich" for rich individuals and "poor" for poor individuals and $y_{rich} > y_{poor}$: $\frac{dp}{dx}\frac{x}{p} = \frac{1}{\alpha}\frac{tx}{y_i - tx}$. In graphic terms, this means that the slope of the bid-rent curve gets adjusted based on the respective income level, i.e. either rich or poor (figure on the right depicts envelope bid-rent curve, where infinite intermediate income levels are added (Figure 2).

Figure 2. Income-adjusted individual bid rent curves



Note: Y-axis depicts the price per unit of living area, x-axis depicts the distance from CBD. Red curve depicts bid rent curve of low-income individual, green curve depicts bid rent curve of high-income individual. The arrow means that the two households (dots) are better off switching location.

It can be interpreted that the poorer the household, the steeper the bid-rent curve. This is because a higher income results in a higher consumption of both the generic good c and the living area q, as well as due to the fact that a higher consumption of the living area q is costlier at a high per-unit price of land (as compared to a household consuming little living space q). As a result, low-earning households are willing to pay more for a specific living area q near the CBD than high-earning households would be.

This model extension is, however, subject to several drawbacks (Kraus, 2006).For example, it ignores that high earners have a higher value of time, i.e. their willingness to pay to avoid commuting is higher. Hence, high earners are more likely to invest in a car or a better located area of residence. Moreover, as commercial centres, offices and other employment poles have positioned themselves on larger surfaces in the periphery, cities have lost their monocentric shape. As this extension is based upon the monocentric city model, it fails to account for the fact that urban areas might now contain multiple attraction poles, which might give ground to a new redistribution of income groups across space.

2.1.4. Age-specific preferences

The amplitude of the factors which drive individuals to relocate to another municipality also vary across different age categories. Specific age groups might, just like specific income groups, have different priorities than others. Childless young professionals aged 20 to 30, for example, might be more tempted to locate in the proximity of a labour market where they are likely to find an interesting and well-paid job with the qualifications they have acquired. Households with one or more children, on the other hand, might be more likely to move to a green suburb with a particularly good kindergarten or school to facilitate a better upbringing of their children.

This chain of thought is picked up by the "upward social class escalator", a term coined by Fielding (1992): In a paper examining the contention that South East England acts as a region where young people immigrate to boost their career (an upward social class escalator), it is found that the region has an overproportionate share of potential upward-mobile young adults immigrating into the area as it promotes these young adults at a faster pace than any other region in the country. However, a large proportion of these young adults "step off the escalator" once they reach a certain promotion level, i.e. they emigrate from South East England once they attain a certain education level and a job with a satisfying salary.

2.2. Brussels and its commuter zone

Brussels and its commuter zone are located in one of the most urbanized regions in Europe (Poelman & van Rompaey, 2009). The Brussels-Flanders region has a population density of 515 inhabitants per squared kilometer and caters a highly polynucleated urban system. The so-called *Flemish Diamond* region concentrates various industrial, commercial, service, logistic and research activities. Compared to the rest of Europe, the Flanders-Brussels region has a significantly larger percentage of built-up land, as seen in Table 1.

Table 1. Percentage of built-up land and average distance to built-up land in Flanders-Brussels and abroad (Source: Poelman & van Rompaey, 2009)

Area	Percentage of built-up land	Average distance to built-up land
Flanders-Brussels	**26%**	**539**
EU	4.8%	8924
Belgium	20%	721
The Netherlands	11.5%	1579
France	5%	2385
United Kingdom	7.5%	5636
Germany	8%	1496

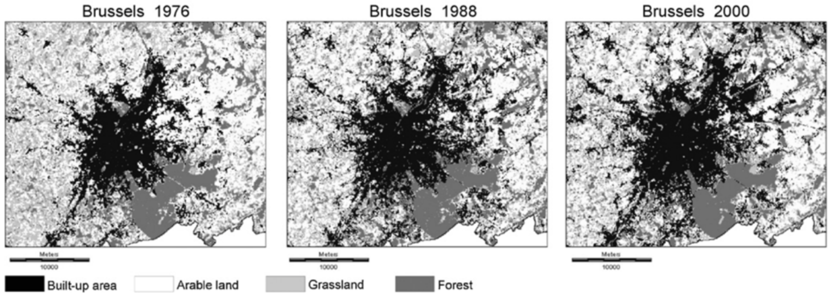
In fact, the metropolitan region of Brussels is characterized by a very scattered urbanization pattern, which originates from its medieval settlement structure (Poelman & van Rompaey, 2009): Already in the middle ages, there was a high road density, which triggered a diffusion process of urban areas after World War 2. Moreover, since the 1960s, there has been a lot of accessible cheap open space, which attracted large scale retail activities, which in their turn attracted residential areas (Antrop, 2004). As the local spatial planning was not so rigid due to a rather permissive spatial policy (with the exception of the forested zones where urban development is strictly prohibited) until 1995, the landscape adopted a highly fragmented character: Large areas of arable land and grassland were transformed into built-up commercial and residential areas. Holden and Turner (1997) refer to Flanders as a highly fragmented area with the most “American-like” spatial pattern of urbanization in Europe.

With LANDSAT satellite imagery, Poelman and Van Rompaey (2009) studied the urban expansion in two study areas between 1976 and 2000 in (1) the highly urbanized region of Brussels and (2) the semi-urbanized region of Hageland (east of Brussels).

Poelman and Van Rompaey (2009) reproduced the urban expansion pattern of 2000 by means of a spatial model based upon a so-called suitability map. But in order to create this map, they first had to examine what makes land suitable for new built-up land: Results have shown that the accessibility to the employment market is a significant controlling factor, as new built-up land is found predominantly in the vicinity of higher unemployment potential areas, i.e. around the city of Leuven and near Brussels. New built-up land is also mainly developing in the immediate surroundings of local roads, and national and secondary roads to a lesser extent. In their Brussels study area, the distance to the motorway entrance points is also moderately significant. Finally, flood risk plays a significant role in shaping the urban expansion.

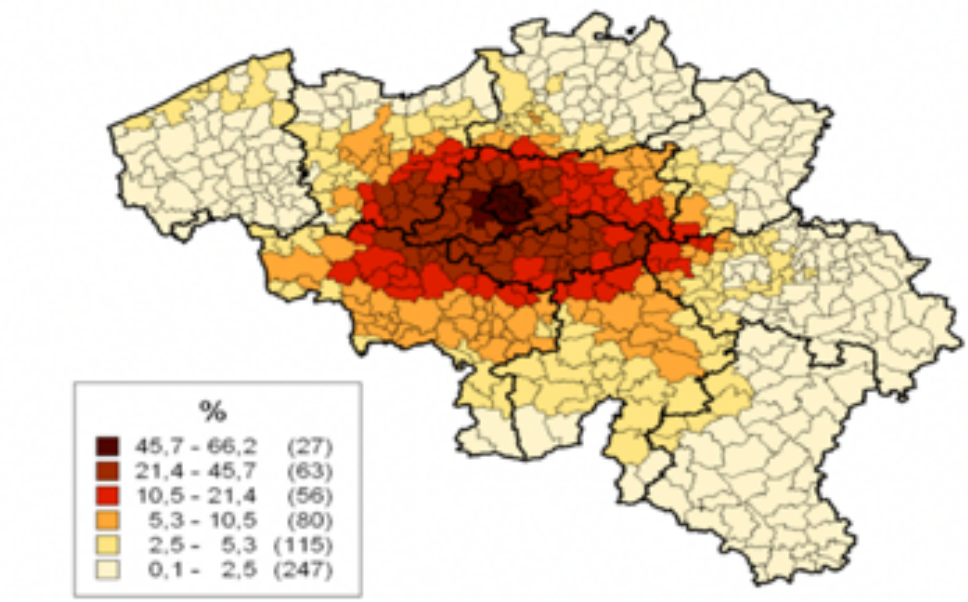
Regarding the expansion pattern, their study reveals that a concentric growth pattern occurred in historical urbanized areas, whereas in semi-urban areas the urban expansion followed a significantly more fragmented pattern: In the Brussels study area, the built-up area grew from 19.1% in 1976 to 31.7% in 2000 (Figure 1). In the Hageland study area, the built-up land grew from 7.9% in 1976 to 20.0% in 2000, whereby the urban expansion followed a much more scattered pattern, which consists of a number of urban centres.

Figure 3. Land cover in Brussels in 1976, 1988 and 2000 (Poelman & Rompaey, 2009)



However, Poelman and van Rompaey (2009) limit their Brussels study area – in which they identify a concentric growth pattern - to the 19 municipalities shaping the Brussels-Capital Region and its 17 adjacent municipalities, whereas the commuting patterns indicate that the metropolitan region goes far beyond that (Figure 2): There are 118 municipalities, where at least 15% of the working population commute to the Brussels-Capital Region on a daily basis. The commuting structure between the inhabitants' workplaces and residences is a widespread key-criterion that allows to map the hinterland of a geographic area (Thisse & Thomas, 2010). Eurostat (2018) defines a Functional Urban Area (FUA) as an area consisting of a densely inhabited city core and a less densely populated commuting zone whose labour market is highly integrated with the city, or more precisely, where at least 15% of employed residents work in the city.

Figure 4. Municipalities of Belgium by proportion of working population working in Brussels. (Source: STATBEL, 2016)

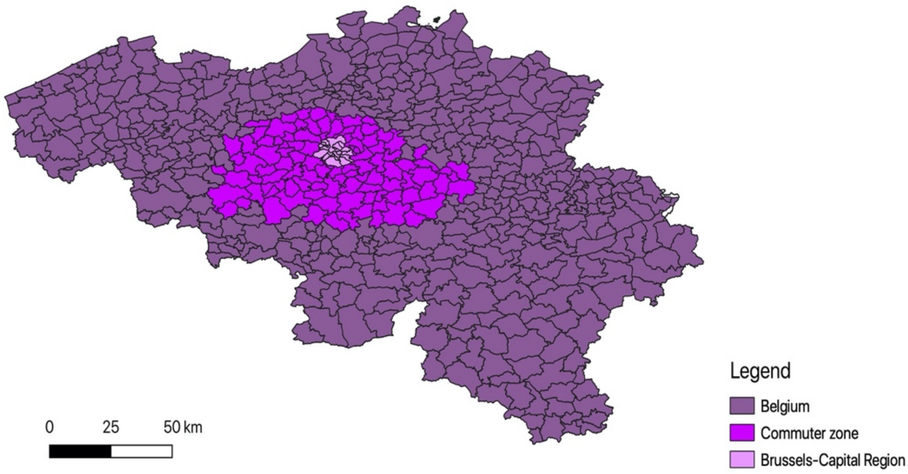


Note: The redder the municipality, the higher the percentage of the working population, which daily commutes to the Brussels-Capital Region

Section 3: Data

The analysis of the relocation patterns in Brussels and its commuter zone rests on a cross-sectional dataset covering 118 observations and 17 sections. Annual information on relocation flows and potential determinants is available at a municipality (NUTS3 level). The dataset considers all municipalities where at least 15 per cent of the working population commute to Brussels on a daily basis, in accordance with Eurostat's definition of a Functional Urban Area. This amounts to a total of 118 municipalities, including the 19 municipalities constituting the Brussels-Capital Region. These municipalities are depicted in Figure 3.

Figure 5. Map of Belgium and the study area



To generate data on population growth across these 118 municipalities, the population census data from STATBEL is used, from 1 January 2018, 1 January 2019 and 1 January 2020. The total population numbers for these 3 years were extracted. The yearly births and deaths are extracted from the same source to compute the natural growth per municipality (which is excluded from the population growth variable in order to account solely for the growth resulting from migration to/from the municipalities). Moreover, the censi include age-specific population numbers for these 3 years, namely (1) the number of 20 to 30 years old inhabitants and (2) 40 years old and older inhabitants, as well as income-specific population numbers, namely (1) workers earning less than €20000 and (2) workers earning more than €50000 a year.

To investigate the impact of a selection of probable push and pull factors on the relocation patterns across the study area, data has been extracted from various sources:

1. Firstly, to investigate the impact of productivity-related push and pull factors, information on labour market indicators are extracted from the Walloon and Flemish regional statistical office: For each municipality, these include the average income, the unemployment rates (between 2015 and 2019) and the number of employees working in the municipalities in defined sectors. The latter is used to compute the proportion of the local workforce employed in the five sectors that experienced the highest growth in jobs between 2010 and 2019 (namely the education sector, IT-related sectors, body health sector, mental health sector and administrative jobs).

2. Secondly, to investigate the impact of consumption-related push and pull factors, the location of selected amenities across Brussels and its commuter zone were extracted from QGIS' OSM Plugin. These amenities include restaurants, hospitals, cinemas, schools and universities. In the dataset, the number of these amenities per capita are given on a municipality level, which are computed via the "count in polygon" function.

3. Thirdly, to investigate the impact of the connectivity of the municipalities, the distance and the travel time to the historical city centre of Brussels is computed. The distance has been extracted from a distance matrix executed on QGIS. The travel times to the historical city centre (placed at Gare Centrale / Centraal Station) is computed on three layers on QGIS, namely on the road network (extracted from data.gov.be), public transport network (extracted from the public transport network providers' websites) and bike network (extracted from data.gov.be). The TravelTime plugin adjusts the travel time with data on congestion. The fastest time among these three – on a Monday at 08:00 - is eventually selected as the travel time to Brussels.

4. Finally, to investigate the impact of the safety of the municipalities, the number of crimes per municipality in the timeframe is extracted from the stat.policefederale.be. These crimes include burglaries and car thefts.

Section 4: Methodology

As suggested in the literature, the growth of different cities and neighbourhoods depends on productivity-related factors such as an expansive labour market or the presence of growing economic sectors (Alperovich, 1988), as well as on consumption-related amenities such as a high density of restaurants or a low crime rate (Glaeser, 2001). However, specific population segments are considered to be more sensitive to some factors. But studies conducted in other areas showed that several push and pull factors affect migration across various age and income groups. Thus, the first hypothesis is:

H1: The presence of a favourable employment environment, low crime rates and good connectivity have a positive effect on the net migration rate of a municipality.

The regression equation tests several hypothesized factors on the municipalities' net migration rate:

$$nmr_i = \beta_o + \beta_1 unempr_i + \beta_2 topsectorr_i + \beta_3 burgl_i + \beta_4 cartheft_i + \beta_5 cartime_i + \beta_6 pttime_i + \beta_7 restoperkm2_i + u_i$$

The dependent variable is the net migration rate of municipality i in period 2017-2019, denoted nmr_i. The net migration rate is computed as the total net migration balance from 1 January 2017 until 31 December 2019 per 100 inhabitants. To account for the population growth due to natural growth, the total net migration balance is computed as the increase in population between 2017 and 2019 minus the natural growth, i.e. population change + deaths – births. Hence, the net migration rate can be defined as the population growth explained by migration, as a percentage of the total population.

The right-hand side of the regression equation includes the constant β_O, seven coefficients and independent variables which correspond to the push and pull factors the relocation patterns are possibly based on (as suggested in the reviewed literature) and the error term ε_O.

Two productivity-related and five amenity-related push and pull factors are considered:

- the average unemployment rate of municipality i in the period 2015-2019*, denoted as* $unempr_i$
- the proportion of the workforce of municipality i in the period 2015-2019 working in the five sectors which experienced the highest nationwide increase in jobs, denoted as $topsectorr_i$
- the average yearly burglaries (per 100 households) and car thefts (per 100 cars) committed in municipality i in the period 2015 to 2019, denoted as $burgl_i$ and $cartheft_i$
- the travel times to Brussels on a Monday morning at 08:00 from municipality i by car and by public transportation, denoted as $cartime_i$ and $pttime_i$
- the number of restaurants per squared kilometer in municipality, denoted as $restoperkm2_i$

Individuals require some time to internalize the changes in explanatory variables. Hence, it is likely that the individuals will not relocate as soon as they lose their job or as soon as a sudden increased number of crimes occur in their municipality. If individuals relocate to another municipality, the rest of their household/family often relocate too, which means that potentially their children will have to attend another school or that their partner(s) will have to increase their commuting costs to their job, or take some time to find another one in the new municipality. Hence, the adjusted regression equation takes into account the potentially slow adjustment in the net migration rate after a change in the explanatory variables. So now, the equation will examine the association between the net migration rate in the period 2017 to 2019 in response to the average of the explanatory variables in the years 2015 to 2019.

The second group of regression equations takes into account the different sensitivities to specific push and pull factors across different age groups. As Fielding (1992) suggested in his study, large employment hubs such as South East England tend to attract above-average young immigration, as young students and professionals hope to undergo an "upward social class escalator", whereby they hope to attain a satisfying education and job promotion level. However, at a certain age, when they achieve a satisfying education and job promotion level, they are often tempted to emigrate from the region. Moreover, young population segments are considered to be less sensitive to crime and more sensitive to the local cultural vivacity and the local public transport infrastructure, as they are less likely to own a car. Therefore, the second hypothesis is:

H2: The presence of a favourable employment environment and amenities have a positive effect on the proportion of 20 to 30 year old citizens in a municipality.

Hence, the second regression equation will test whether the Brussels commuter zone can also be considered as an escalator region. More precisely, a third regression equation will be added and the two equations will seek to explain the number of 20-to-30-year-olds and the number of 40+ citizens as a proportion of the total municipality population, based upon several hypothesized explanatory factors. Therefore, the second and third regression equations are:

(1) $youngprop_i = \beta_o + \beta_1 unempr_i + \beta_2 topsectorr_i + \beta_3 burgl_i + \beta_4 cartheft_i + \beta_5 cartime_i + \beta_6 pttime_i + \beta_7 distanceuni_i + \beta_7 restoperkm2_i + u_i$

(2) $oldprop_i = \beta_o + \beta_1 unempr_i + \beta_2 topsectorr_i + \beta_3 burgl_i + \beta_4 cartheft_i + \beta_5 cartime_i + \beta_6 pttime_i + \beta_7 distanceuni_i + \beta_8 restoperkm2_i + u_i$

The structure of these regression equations highly resembles the first equation. However, the dependent variables are $youngprop_i$ and $oldprop_i$, denoting the proportion citizens aged 20-30 and 40-112 in municipality i. The independent variables consist of the same eight explanatory variables, as all of these are hypothesized to demonstrate varying effects on the different age groups.

Finally, the third group of regression equations tests the weight of the hypothesized explanatory factors on the presence of different income groups in the study area. As predicted by the monocentric city model, low earning households often end up locating in the central neighborhoods in spite of the higher real estate prices due to their steep bid-rent curve (Alonso, 1964 & Mills, 1972). As mentioned in the literature review, higher income households tend to purchase a larger living area and therefore bear higher costs at a high per-unit price of living area as compared to a household consuming little living space. As a result, low-earning households often end up in the city centre. Moreover, high income individuals tend to consume more consumption goods as well (denoted as c in the monocentric city model) and attend restaurants at a higher frequency. Hence, the third regression equation is:

H3: The density of restaurants and the distance from the city centre has a positive effect on the proportion of individuals earning more than €50000 in a municipality.

Therefore, the final two regression equation test the effect of several hypothesized explanatory factors, including the distance from the city centre, on the number of high-income and low-income individuals, as a proportion of the total municipality population. Hence, the fourth and fifth regression equations are:

(3) $lowearnprop_i = \beta_o + \beta_1 unempr_i + \beta_2 topsectorr_i + \beta_3 burgl_i + \beta_4 cartheft_i + \beta_5 cartime_i + \beta_6 pttime_i + \beta_7 restoperkm2_i + \beta_8 distance_i + \varepsilon_o$

(4) $highearnprop_i = \beta_o + \beta_1 unempr_i + \beta_2 topsectorr_i + \beta_3 burgl_i + \beta_4 cartheft_i + \beta_5 cartime_i + \beta_6 pttime_i + \beta_7 restoperkm2_i + \beta_8 distancebxl_i + \varepsilon_o$

The structure of these regression equations again highly resembles the equations above. However, the dependent variables are $lowearnprop_i$ and $highearnprop_i$, which denote the proportion of income declarations with after-tax incomes below €20000 a year and the proportion of income declarations with after-tax incomes above €50000 a year, as a proportion of the total number of income declarations in municipality i. The independent variables consist of the same eight explanatory variables, as all of these are hypothesized to demonstrate varying effects on the different age groups. Moreover, a ninth explanatory variable is added, namely $distancebxl_i$, which denotes the distance of municipality i from the Brussels Central Station (Bruxelles-Centrale/Brussel-Centraal). This variable is added to what extent the population structure of Brussels follows the monocentric city model in terms of income group distribution.

Finally, each of the multiple linear regression equations will be tested for heteroskedasticity with the Breusch-Pagan test in order to ensure that the errors are normally distributed. This will be done by estimating the statistical association between the square residuals of all observations and the coefficients of the dependent variables. If we fail to reject the null hypothesis that there is no statistical association between the error term and the coefficients, we will choose robust errors in order to control for any heteroskedasticity. As the sample is fairly large, asymptotic normality is assumed.

Section 5: Descriptive Statistics

In this section, a few summary statistics as well as descriptive maps will be provided, which will serve as a preliminary indication for the association between the location decision patterns and the hypothesized explanatory variables. The section will be divided into two segments: First, the migration trends across the municipalities are described. Then, the location choices according to age, and finally the location choices according to income group will be illustrated along with their summary statistics.

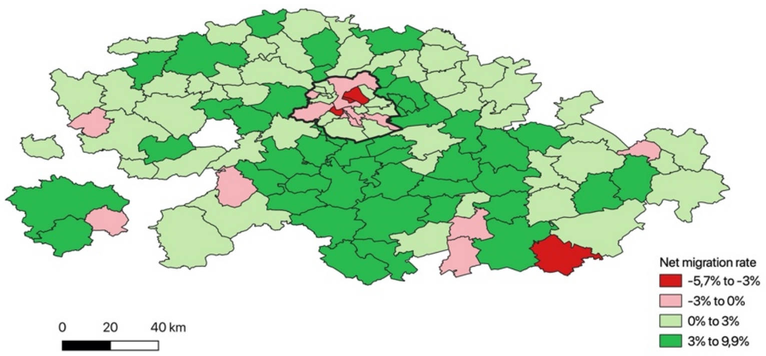
5.1. Distribution of net migration rates

Table 2. Net migration rate, per municipality – summary statistics.

	N	Minimum	Maximum	Mean	Std. Dev.
Net migration rate	118	-5.70	9.94	2.53	2.27

As can be seen in Table 2, the net migration rate (the population growth/decline explained by migration per 100 inhabitants) varies across the different municipalities. Among the 118 observed municipalities, the lowest net migration rate is -5.70%, which is the rate for Saint-Josse, a municipality in Brussels-Capital Region. This means the population decline in 2017-2019 explained by migration amounted to 5.7% of its population. The highest net migration rate is in Dilbeek (9.94%) in the western periphery of Brussels. The mean in the entire study area is 2.53% and the standard deviation is 2.27%.

Figure 6. Net migration rates (in %) in Brussels and its commuter zone, by municipality.



In Figure 6, the map illustrates the distribution of the net migration rates across the study area. The Brussels-Capital Region is marked by the thick black contour. It can be interpreted that – with the exception of a few municipalities in the outer commuter zone, lowest net migration rates can be found within the Brussels-Capital Region, whereas the highest net migration rates can be found in the southern periphery and other suburbs bordering the Brussels-Capital Region.

5.2. Distribution of age group proportions

Table 3. Proportion of population aged 20 to 30, per municipality– summary statistics.

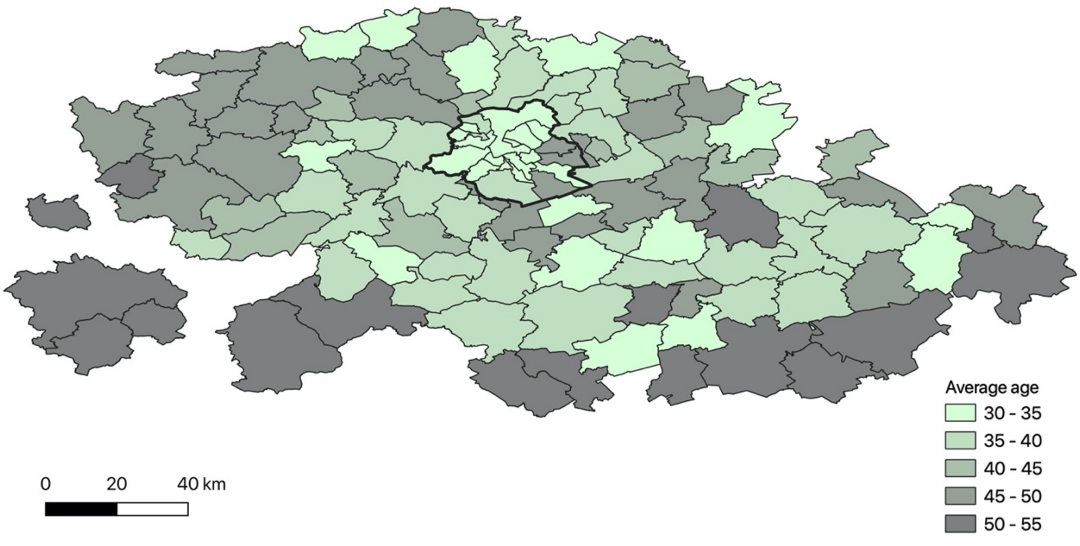
	N	Minimum	Maximum	Mean	Std. Dev.
Proportion of population aged 20-30	118	12.51	26.52	15.44	2.30

Table 4. Proportion of population aged 40 and older, per municipality – summary statistics.

	N	Minimum	Maximum	Mean	Std. Dev.
Proportion of population aged 40+	118	38.54	57.99	50.66	4.52

Table 3 reveals that the proportion of population aged 20 to 30 counts only 12.51% in the rural municipality of Landen, whereas in Ixelles (central municipality in Brussels-Capital Region) and Leuven (a student city) both have a population aged 20 to 30, which accounts for 26.5% of their total population. The lowest proportion of inhabitants aged 40+ is found in Saint-Josse (another central municipality) and the highest proportion of 40+ is found in Lasne (an affluent suburb in the southern commuter zone). Figure 7 illustrates that the average age follows a concentric pattern, i.e. the further the municipality from the city centre, the older its population.

Figure 7. Average age in Brussels and its commuter zone, by municipality.



5.3. Distribution of income group proportions

As assumed by the monocentric city model, the share of low-income people decreases as we distance ourselves from the city centre (Figure 8). The highest share of incomes below €20000 can be found in Saint-Josse, where 65% of the working population earns less than €20000 per year. The lowest share of incomes below €20000 are found in Geraardsbergen, where 28% of the working population earns less than €20000 per year. When it comes to the proportion of incomes above €50000 (Table 6), the mean municipality in the study area has approximately 45% of its population belonging to this population segment.

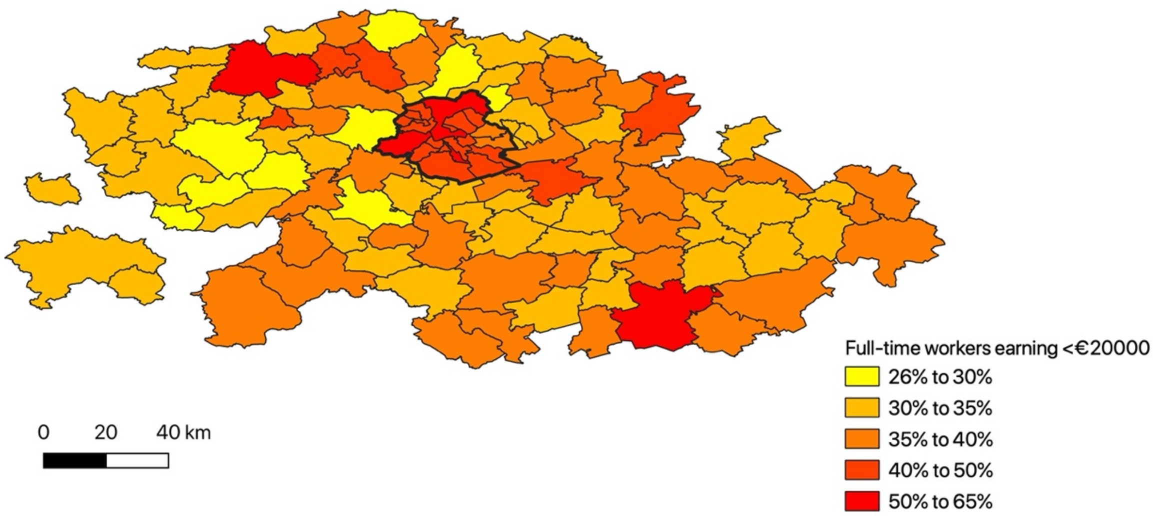
Table 5. Proportion of incomes below €20000 – summary statistics.

	N	Minimum	Maximum	Mean	Std. Dev.
Proportion of population earning less than 20000€	118	26.22	65.17	36.14	7.13

Table 6. Proportion of incomes above €50000 – summary statistics.

	N	Minimum	Maximum	Mean	Std. Dev.
Proportion of population earning more than 50000€	118	17	88.02	45.01	4.52

Figure 8. Percentage of incomes below €20000 in Brussels and its commuter zone, by municipality.



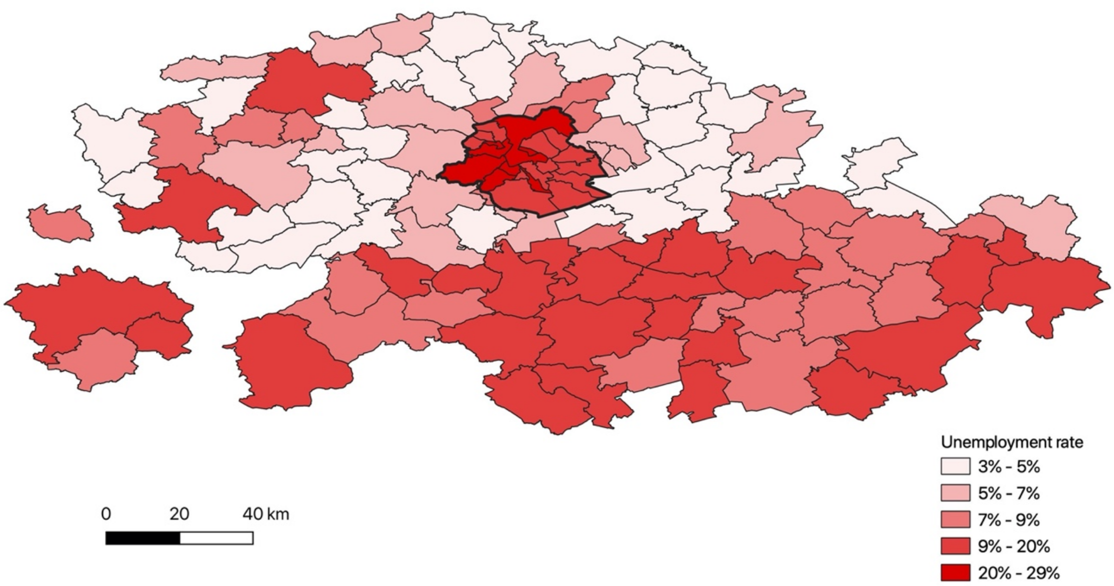
5.4. Distribution of hypothesized explanatory variables

In this section, the productivity- and amenity-related characteristics of the municipalities will be illustrated. These characteristics are hypothesized to explain the distributions depicted in the three maps above. These can serve as an indication for any spatial correlation between the migration/age/income distribution and the explanatory variables depicted in this section.

Table 7. Summary statistics of selected hypothesized explanatory variables.

	N	Minimum	Maximum	Mean	Std. Dev.
Unemployment rate (%)	118	3.0	29.0	9.16	5.27
Top sector rate (%)	118	19.1	84.1	41.33	13.33
Burglaries (per 100 households)	118	0.44	2.88	1.24	0.43
Car thefts (per 100 registered cars)	118	0	0.49	0.12	0.10
Car travel time to Brussels (min)	118	3	89	48.97	19.14
PT travel time to Brussels (min)	118	1	24	2.86	3.62

Figure 9. Distribution of unemployment rates in Brussels and its commuter zone, by municipality.



As can be seen in Figure 9 and the standard deviation in Table 7, the unemployment rates vary vastly across the study area, although clear spatial patterns are to be recognized. Within the Brussels-Capital Region, unemployment rates average 22%. Moreover, with the exception of Aalst and Geraardsbergen, the Dutch-speaking part of the commuter zone has considerably lower unemployment rates.

Figure 10. Distribution of burglaries per 100 inhabitants in Brussels and its commuter zone, by municipality.

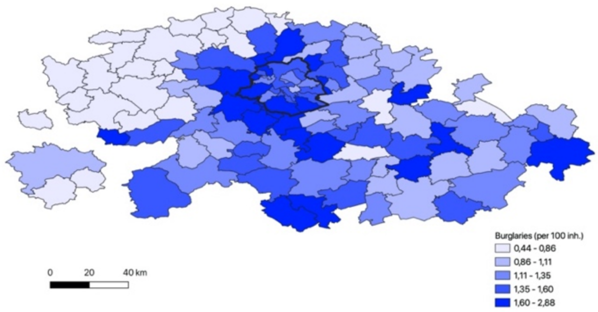


Figure 10 depicts the number of burglaries (per 100 households) across the study area. The values range between 0.44 burglaries per 100 households (found in Zottegem) and 2.88 in Linkebeek. The western commuter zone has experienced a lower propensity of burglaries, whereas Brussels, its inner suburb and its southern suburbs are most exposed to burglaries.

Figure 11. Distribution of travel times to Brussels by car, by municipality.

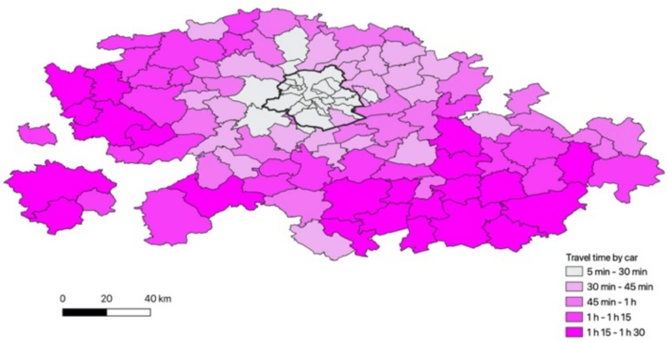
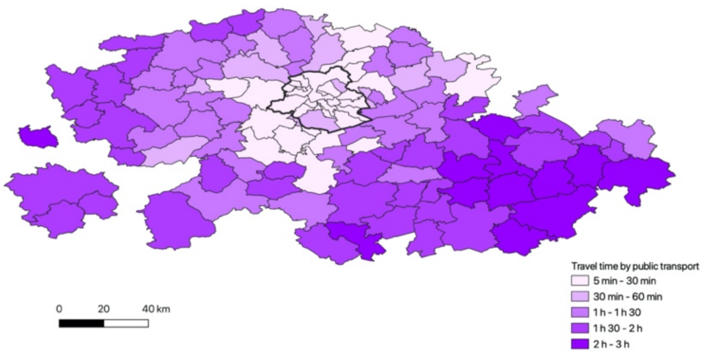


Figure 12. Distribution of travel times to Brussels by public transport, by municipality.



Finally, Figure 11 compares the travel times to Brussels across the study area according to the travel mode: car or public transport: As we distance ourselves from the city centre, the travel times increase for both car and public transport, although the car times follow a slightly clearer concentric pattern. Meanwhile, cities like Leuven dispose of a very good public transport accessibility to Brussels in spite of its substantial distance.

Section 6: Results

In the following section, the results with regards to the three segments of the methodology will be presented: Firstly, the regression of the overall net migration on the hypothesized explanatory factors across the different municipalities will be presented. Then, the regression of location choice on the hypothesized explanatory factors across different age groups will be presented. Finally, this section will end with a presentation of the regression of the proportion of the different income groups on the hypothesized explanatory factors across the study area.

6.1. Results on net migration rates

As seen in Figure 6, the net migration rate differs across municipalities, whereby some municipalities have an overproportionate inward or outward migration. Specific spatial patterns were interpreted, such as a predominantly negative net migration rate within the Brussels-Capital Region and a positive net migration rate in the suburbs, especially in the southern commuter zone. In order to explain this spatial distribution, the first regression equation tests which factors explain the net migration rate across the different municipalities. Hence, the dependent variable is net migration rate and these hypothesized explanatory factors are the independent variables: average unemployment rate, average top sector rate, propensity of burglaries, propensity of car thefts, travel time by car, travel time by public transport and the density of restaurants (see Section 4 for specification of variables).

Table 8. Regression with net migration rate as dependent variable.

Model	Unstandardized coefficients		t	Sign.
	B	Robust Std. Err.		
(Constant)	2.265	1.377	1.64	0.103
Average unemployment rate	-0.180	0.100	-1.81	0.033**
Average top sector rate	0.017	0.018	0.92	0.360
Average burglaries per 100 households	0.279	0.705	0.40	0.693
Average car thefts per 100 cars	1.282	5.208	0.25	0.806
Travel time by car to Brussels	0.001	0.014	-0.05	0.459
Travel time by public transp. to Brussels	0.014	0.007	1.95	0.043**
Restaurants per squared kilometre	0.008	0.215	-0.37	0.713
	Breusch-Pagan test:	F(7, 118) = 3.22	Prob > χ^2 = 0.0031	

Note: **p<0.05, *p<0.1

In Table 4, the results from the regression of the hypothesized explanatory factors on the net migration rate are presented. The regression is subject to heteroskedasticity and thus contains robust standard errors. A 1% increase in the average unemployment rate was found to decrease the net migration rate by -0.18%, i.e. for every 1% increase in the average unemployment rate the population growth explained by migration decreases by -0.18%. The effect of the percentage of the local workforce working in one of the five top sectors is also examined: A 1% increase of the top sector rate is associated with a 0.01% increase in the net migration rate. Thus, the relevance is low and is not significant on a 10 level either. Regarding the propensity of local crime, controversial results are found: For every burglary per 100 households, the net migration rate increases by 0.28%, whereas for every car theft per 100 households, net migration rate increases by 1.28%. Finally, for the travel times, it can be interpreted that for every additional minute of travel time by car, the net migration rate increases by 0.001%. Meanwhile, for every additional minute of travel time by public transport, the net migration rate increases by 0.014%. Thus, for an additional hour of travel time by public transport, the net migration rate increases by 0.84. However, the significance of all explanatory variables except for the average unemployment rate and the travel time by public transport are below the confidence level of 5%. Therefore, no statistical conclusions can be drawn from these outcomes. Still, the key takeaway of this regression is that a favourable employment opportunities are associated with an increasing net migration rate, whereas amenities such as low crime and accessibility are not the priority when relocating to/from a municipality in the study area.

6.2. Results on age group proportions

In Figure 7, we saw that the average age varies considerably across the municipalities. Specific spatial patterns were interpreted, such as a predominantly young population within the Brussels-Capital Region and certain student cities. In order to explain this spatial distribution, two regression equations have been formulated, testing the proportion of the 20-30 years old and the proportion of 40+ years old - respectively - on a number of hypothesized explanatory factors. Thus, the dependent variable of the first regression equation is “proportion of 20-30 years old” (Table 9) and the dependent variable of the second regression is “proportion of 40 years old and older” (Table 10). The independent variables are the set of hypothesized explanatory factors.

Table 9. Regression with "proportion of 20-30 years old" as dependent variable

Model	Unstandardized coefficients		t	Sign.
	B	Robust Std. Err.		
(Constant)	14.113	0.947	14.91	0.000**
Average unemployment rate	0.182	0.050	3.67	0.000**
Average top sector rate	0.006	0.008	0.82	0.412
Average burglaries per 100 households	0.503	0.375	-1.34	0.183
Average car thefts per 100 cars	0.308	2.558	-0.12	0.904
Travel time by car to Brussels	0.007	0.010	-0.74	0.460
Travel time by public transp. to Brussels	-0.009	0.004	-0.16	0.870
Distance to nearest university	-0.017	0.020	-0.86	0.390
Restaurants per squared kilometre	0.095	0.033	2.86	0.005**
	Breusch-Pagan test:	F(8, 118) = 62.34	Prob > χ^2 = 0.0021	

Note: **p<0.05, *p<0.1

Table 10. Regression with "proportion of 40 years old and older" as dependent variable

Model	Unstandardized coefficients		t	Sign.
	B	Robust Std. Err.		
(Constant)	55.392	1.769	31.31	0.000**
Average unemployment rate	-0.516	0.058	-8.86	0.000**
Average top sector rate	-0.040	0.015	-2.52	0.013**
Average burglaries per 100 households	-0.952	0.645	1.48	0.043**
Average car thefts per 100 cars	-4.142	3.274	-1.27	0.209
Travel time by car to Brussels	-0.022	0.020	1.11	0.270
Travel time by public transp. to Brussels	0.002	0.011	0.27	0.790
Distance to nearest university	0.079	0.055	1.44	0.154
Restaurants per squared kilometre	-0.092	0.029	-3.21	0.002**
Breusch-Pagan test:	F(8, 118) = 62.34	Prob > χ^2 = 0.0021		

Note: **p<0.05, *p<0.1

As can be seen in Table 9, the proportion of 20 to 30 year old citizens across the municipalities is associated with several explanatory factors. Regarding the crime factors, it has been found that this age segment is not sensitive to crime: For every burglary per 100 inhabitants, the proportion of this age segment increases by 0.503%. For every car theft per 100 inhabitants, the proportion of this age segment increases by 0.308%. Regarding the connectivity factors, it has been found that for every additional minute of car travel time, the proportion of this age segment increases by 0.007%, whereas the for every additional public transport minute, the proportion decreases by 0.009%. Finally, for every kilometre of distance from the nearest university, the proportion decreases by 0.017% and for every new restaurant per km^2, the proportion increases by 0.095%. Finally, the average unemployment rate is positively associated with the proportion of this age segment, but so is the average top sector rate. However, the significance of all factors, except for the average unemployment rate, burglary propensity and the restaurants per km2 are below the confidence level of 5% and are therefore no indication for any statistical conclusion. Still, the key takeaway is that the proportion of 20 to 30 year old people increases as the crime propensity, the accessibility by public transportation, the density of restaurants and the accessibility of universities increase. In Table 10, where the proportion of the 40+ population is regressed on the same set of hypothesized explanatory factors, the coefficients of the dependent variables are negative if the coefficients in Table 9 are positive and vice-versa, whereby the negative effect is statistically significant for the average top sector rate as well.

6.3. Results on income group proportions

In Figure 8, we saw that the proportion of full-time workers with a yearly salary below €20000 varies considerably across the municipalities. Specific spatial patterns were interpreted, such as a large presence of this income group within the Brussels-Capital Region and the South East of the study area. In order to explain this spatial distribution, two regression equations have been formulated, testing the proportion of the low earners (full-time workers earning <20000€) and the proportion of high earners (full-time workers earning >50000€) - respectively - on a number of hypothesized explanatory factors. Thus, the dependent variable of the first regression equation is “proportion of incomes below €20000” (Table 11) and the dependent variable of the second regression is “proportion of incomes above €50000” (Table 12). The independent variables are the set of hypothesized explanatory factors respectively.

Table 11. Regression with "proportion of incomes below €20000" as dependent variable

Model	Unstandardized coefficients		t	Sign.
	B	Robust Std. Err.		
(Constant)	25.392	1.467	17.31	0.000**
Average unemployment rate	1.230	0.077	15.92	0.000**
Average top sector rate	0.010	0.016	0.63	0.533
Average burglaries per 100 households	-0.267	0.561	-0.48	0.635
Average car thefts per 100 cars	0.931	4.242	0.22	0.827
Travel time by car to Brussels	0.016	0.019	0.82	0.417
Travel time by public transp. to Brussels	-0.016	0.009	-1.76	0.082*
Distance to Brussels	-0.034	0.026	-1.34	0.089*
Restaurants per squared kilometre	0.036	0.014	2.67	0.009**
Breusch-Pagan test:	$F(8, 118) = 62.34$	$Prob > \chi^2 = 0.0029$		

Note: **p<0.05, *p<0.1

Table 12. Regression with "proportion of incomes above €50000" as dependent variable

Model	Unstandardized coefficients		t	Sign.
	B	Robust Std. Err.		
(Constant)	94.996	10.435	9.10	0.000**
Average unemployment rate	-3.711	0.381	-9.75	0.000**
Average top sector rate	0.095	0.117	0.82	0.417
Average burglaries per 100 households	3.566	2.621	1.36	0.177
Average car thefts per 100 cars	-19.889	22.139	-0.90	0.371
Travel time by car to Brussels	-0.149	0.118	-1.26	0.041**
Travel time by public transp. to Brussels	0.173	0.048	3.58	0.001**
Distance to Brussels	-0.139	0.147	-0.95	0.344
Restaurants per squared kilometre	-0.021	0.072	-0.29	0.774
Breusch-Pagan test:	$F(8, 118) = 62.34$	$Prob > \chi^2 = 0.0029$		

Note: **p<0.05, *p<0.1

In Table 11, the output of the regression with “proportion of incomes below €20000” as dependent variable is presented. Regarding the employment environment, it is found that the proportion of this income group increases by 1.23% for every 1% increase in the average of the local unemployment rate over the past five years. However, the proportion of this income group is also positively associated with the top sector rate. Regarding the crime rates ambiguous results are found: An increase in burglaries decreases the presence of this income group, whereas an increase in car thefts increases the proportional presence. Regarding the accessibility, the results indicate that the income group is more sensitive to the travel time by public transport, whereas an increase in travel time by car increase the proportional presence of the income group across the municipalities. Finally, the proportion of low this income group decrease as we distance ourselves from the city centre: For every kilometer, the proportion of incomes below €20000 decreaases by 0.03% - and for every new restaurant per squared kilometer, the proportional presence of this income group increases by 0.04%. However, significance levels of all betas are above a significance level of 10%, with the exception of the average unemployment rate, travel time by public transport, density of restaurants and distance to Brussels. Moreover, this regression is subject to endogeneity as decisive variables such as city size are not taken into account and simultaneity bias might also take place: Low earners are likely to have a lower education level and are thus more exposed to unemployment. Hence, it is not the high unemployment rates that attract the low earners, but the high proportion of low earners is responsible for the high unemployment rates in the neighbourhood. Hence, taking into account these endogeneity issues and insignificant variables, we can solely assert that the proportional presence of <20000€ earners is negatively associated with the distance from Brussels and the connectivity by public transportation.

When comparing Table 12 (where the dependent variable are the €50000+ earners) to Table 11, the coefficients have predominantly opposite signs. For example, In contrast to low earners, this income group has a higher proportional presence in low unemployment municipalities and has a lower proportional presence in municipalities where the accessibility by car is low. However, when it comes to distance, both the >50000€ and <20000€ earners’ proportional presence increases as we approach the city centre.

Section 7: Conclusion

The goal of this Bachelor Thesis is to identify the factors that influence migration and location choices in Brussels and its commuter zone. Hence, the following research question was formulated:

"What determines the migration and location choices of individuals across Brussels and its commuter zone?"

However, this research question has been answered from three perspectives, namely by looking at (1) the net migration rate, (2) the proportion of age groups and (3) the proportion of income groups across the municipalities in the study area: First, a literature review was conducted to review the preexisting literature on the economic drivers of relocation. Then, the data that has been gathered for this thesis has been presented, which was thereafter employed to conduct an OLS regressions. In this section, the results from the OLS regressions will be given more meaning by comparing them to the reviewed literature, before finally finding an answer to the formulated hypotheses, again in accordance with the three abovementioned perspectives. Finally, several limitations of this research and recommendations for the private sector, the public sector and citizens will be given.

7.1. Results on net migration rates

To assess the distribution of the migration balance across the Brussels-Capital Region and its commuter zone, the net migration rates in the 118 municipalities were analyzed. When depicting the data retrieved from STATBEL on a map, it was found that the net migration rates are negative in the Brussels-Capital Region and predominantly positive in the commuter zone. Poelman & Van Rompaey (2009) concluded in their research that in the past few decades, the population has positioned itself mainly in the proximity of important employment markets and local roads. Moreover, a concentric growth pattern was found in the Brussels and a scattered growth pattern in the hinterland.

This thesis analyzes relocations in a larger area and only in 2017-2019. However, despite the differences in time and space, the results are similar: As the local unemployment rate falls, the net migration rate is expected to rise. Moreover, net migration rates were found to be the highest in municipalities with a low travel time to Brussels, although only the public transport time was found to be statistically significant. These findings are in line with literature empirically demonstrating a positive relationship between a favourable employment opportunities and the local population growth: Cities were found negatively relate to unemployment and cities' population growth (Pissarides, 1990). However, the hypothesis states that besides a good employment environment and good connectivity, low crime rates also positively associate with the local net migration rate and in this paper, the crime rates' impact has been statistically insignificant. Thus, the results are ambiguous and the hypothesis will be rejected.

7.2. Results on age group proportions

To assess the distribution of age groups across the Brussels-Capital Region and its commuter zone, the proportion of two age categories (20-30 and 40+) has been analyzed in the 118 municipalities. When depicting the data retrieved from STATBEL on a map, it was found that the average are is lower in the Brussels-Capital Region and several larger cities in the outskirts such as Leuven, whereas the majority of the commuter zone is overproportionately old. This corresponds to some extent to the observation made by Fielding (1992), which considers urban agglomerations as "upward social class escalators", whereby students and young professionals position themselves in urban areas to contribute to their early career boost. But at some point, when they attain a certain education level and position in their firms' hierarchies, they emigrate from the region seeking after a higher quality of life.

Saying that this observation goes hand in hand with the data by STATBEL, would however be somewhat ambiguous as this research does not consist of a dynamic model tracking if and where the young population has or will have migrated to. However, when comparing how the 20-30 population reacts to push and pull factors, in comparison with the 40+ population, it has been found that the propensity of city-characteristic amenities and disamenities are positively associated with the proportional presence of the 20-30 year old population. However, in contrast to the escalator model, unemployment rates were found to be positively associated with the proportional presence of this age segment. Therefore, the second hypothesis is rejected.

7.3. Results on income group proportions

To assess the distribution of income groups across the Brussels-Capital Region and its commuter zone, the proportion of incomes below €20000 and the proportion of incomes above €50000 have been analyzed in the 128 municipalities. When depicting the data retrieved from STATBEL on a map, it was found that proportion of low earners (individuals earning less than €20000) was the highest in the Brussels-Capital Region, whereas the suburbs have a significantly lower share of inhabitants falling into this category. The distribution of this income segment follows a fairly concentric pattern, considerably in line with the income-adjusted monocentric city model. Although this paper does not measure the attractiveness of a municipality in terms of housing prices or the willingness to pay for a property, the results speak in favor of a steeper bid-rent curve among the poor. Under the monocentric city model, poorer households have a steeper bid-rent curve. This is because a higher income results in a higher consumption of living area and thus locate in the outskirts to avoid a higher per-unit price of land. As a result, low-earning households are willing to pay more for a living area in the inner city (Alonso, 1964; Mills, 1972).

But high earners have a higher value of time and have therefore a higher willingness to pay to avoid commuting, i.e. they are more likely to invest in a car. This is also reflected in the results of the regression, where the proportional presence of high earners was negatively associated with the travel time to Brussels by car, whereas the low earners were more negatively associated with the travel time to Brussels by public transport – often their only commuting option (besides walking or cycling). However, the presence of other amenities than a good connectivity, such as a high density of restaurants were found to be negatively associated with the presence of high earners in a municipality. This observation is however quite likely to be biased due to an omitted variable, namely the size of the municipality: Larger cities tend to have a higher density of restaurants as well as a higher proportion of low-income individuals, at least in cities with a high proportion of poverty in the inner city such as Brussels. Still with respect to the results from the regression, we reject the third hypothesis.

Now, combining the results from the literature review, the descriptive statistics and the results from the regressions, it is possible to answer the main research question asking: "What determines the migration and location choices of individuals across Brussels and its commuter zone?". On a general population level, migration was found to be significantly negatively associated with the local unemployment rate and increased by the public transport connectivity. Other hypothesized explanatory variables were found to be insignificant. However, when looking into the location choices across different age and income groups, it was found that young people are also locate in areas with a high density of restaurants and low earners position themselves in the proximity of the city centre. Finally, it has to be noted that correlation does not imply causation.

7.4. Recommendations

The results of this research may be useful for policymakers aiming to improve the sustainability of Brussels and its commuter zone. As mentioned in the introduction the metropolitan area of Brussels has experienced an overproportionate migration to the outskirts of the core city and the recent trends seem to confirm a continuation of this phenomenon. This is an alarming observation considering that sprawling cities tend to incur increased economic, environmental and social costs. However, in this research it has been illustrated which population segments are more attracted by the suburbs and what their relocation drivers may be. Therefore, the policymakers could make use of the insights given in this research in their attempt to meet the demands of the various age and income segments. Moreover, based on the results from this research, policymakers can gain a better idea of what the emigrating population segments miss in the city centre.

7.5. Limitations and directions for further research

This research is subject to several limitations. The most important limitation is the difficulty to extract data for the whole commuter zone, as it is divided into three administrative divisions with separate statistical offices. Belgium as a whole has data on the entire population, which are included in the population censuses. However, other data which would have been interesting is collected on a regional basis, i.e. in Wallonia, Flanders and the Brussels-Capital Region respectively. As a result, data on other possible explanatory factors is available only in one of these regions, while other data is not given in differing time periods and is thus not coordinated.

Another limitation is that examining location and relocation choices is a highly subjective matter and would thus require the conduct of a survey, where respondents are asked why they decided to relocate. However, conducting physical surveys has been impeded by the COVID-19 pandemic as physical contact with people is advised or directed to be minimized. An online survey could have been composed, but the sample would be subject to selection bias as the link to the online survey would have be shared across multiple age groups and income groups, which are often highly marginalized. Therefore, it would have been difficult to spread the link across the different population segments.

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