



Co-financed by the European Regional Development Fund

Inspire Policy Making with Territorial Evidence

FINAL REPORT //

Cross-border housing markets in Europe

Indicators of accessibility

Annex No. 9: Technical Annex 3 // July 2022

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housing

Indicators of accessibility

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1 Introduction & Rationale

One of the primary hypotheses for this research was that accessibility might play a major role in determining the price of housing in functional cross-border areas. Hence, we developed for this research a set of indicators focused on interconnecting measures of accessibility with measures of affordability in order to determine if there is a correlation between the level of accessibility and the price of housing. Our suspicion was that dwellings with greater access and proximity to the neighbouring border region and to services of general interest, would in turn have a higher price in housing as these households are better situated to take advantage of benefits from cross-border integration.

In order to develop and measure this indicator of accessibility-cum-housing price, we developed a series of maps for each case study detailing the accessibility in relation to services of general interest such as public transport, health centres, education centres and commercial centres. We define accessibility as a package of different calculations that use the same theoretical framework to deliver information on how close in terms of time are services of general interest in relation to this project specificities. Following the mapping of the accessibility elements, it was then possible to measure for our indicator on whether accessibility plays a major role in determining prices in a cross-border housing market through completing a regression analysis.

Following the calculation of the regressions, we found that there was no indication that accessibility to different services of general interest impacts housing price. Hence, we were not able to corroborate our initial hypothesis that there is correlation between levels of accessibility and housing price. This is as results from the regression analysis are indicative that there is no meaningful correlation between measures of accessibility and housing price. Thus, the prices are determined by other stronger influencing elements, and are most likely subjects to smaller pockets of price determinants. To give an example, while accessibility is important, housing next to railways displays lower prices due to increased noise levels. Yet, to identify these smaller pockets, one would need to observe the markets for a longer period as the most sought-after estates may also not have come on the market in the timeframe of the web scraping.

While we were disappointed that there were no trends for any of the case studies between accessibility and housing price, the process of developing and measuring this indicator still provides for some interesting insights and potential for further future research (see Chapter 4). In tying together accessibility measurements to housing price in border regions, we wished to develop greater cross-border integration and encourage further collaboration on different areas of policy so as to promote greater social cohesion and wellbeing in border regions with regard to housing affordability. By mapping the accessibility of these functional cross-border areas, we were instead able to analyse and understand the extent to which these regions are already integrated. This is to say that the accessibility maps illustrate the different degrees of integrations for six European cross-border areas.

The remainder of the annex proceeds in the following format: Chapter 2 lists the regression correlations through scatter plot charts; Chapter 3 holds the accessibility mappings for each of the case studies; Chapter 4 speaks to potential implications that the trial of this accessibility indicator has on future research.

2 Regressions

This chapter explores the correlation between prices (measured as €/sqm or as €/room in the case of Ireland-Northern Ireland) and accessibility to points of interest covering these categories:

- Access to education centres by car (this includes primary and secondary education centres but not universities)
- Access to education centres by walking (this includes primary and secondary education centres but not universities)
- Access to health centres by car (this includes doctors, hospitals, and pharmacies)
- Access to health centres by walking
- Access to short distance public transportation (bus and taxi stops) by walking
- Access to mid distance public transportation (metro, tramway, ferry stops) by walking
- Access to retail shops by car
- Access to retail shops by walking

The information is segmented by case study and city and by buying/rental market (this results in 6x2x2=24 different combinations).

On the tables, we display the correlation between the unit prices versus each of the accessibility measures. The indicators shown are:

- The Pearson Correlation: a measure that indicates linear correlation, taking a value near 1 when there is a lot of correlation and 0 when there is none. It can also be negative, indicating an inverse correlation
- Significance 2-tailed: the extent to which the result is unlikely to be due to chance alone, taking value closer to zero when the correlation estimation can be confidently assumed to be correct.
- N: the measure of the sample size

The scatter plots show the individual pairs of values for price versus accessibility, organised in a grid of two columns: buying at the left and rental at the right, with each row being one of the services of general interest analysed. As a general comment, we can observe in all the graphs that there is a big dispersion and no clear correlation can be found between price and accessibility, meaning that other variables are determining the price instead.

2.1 Austria

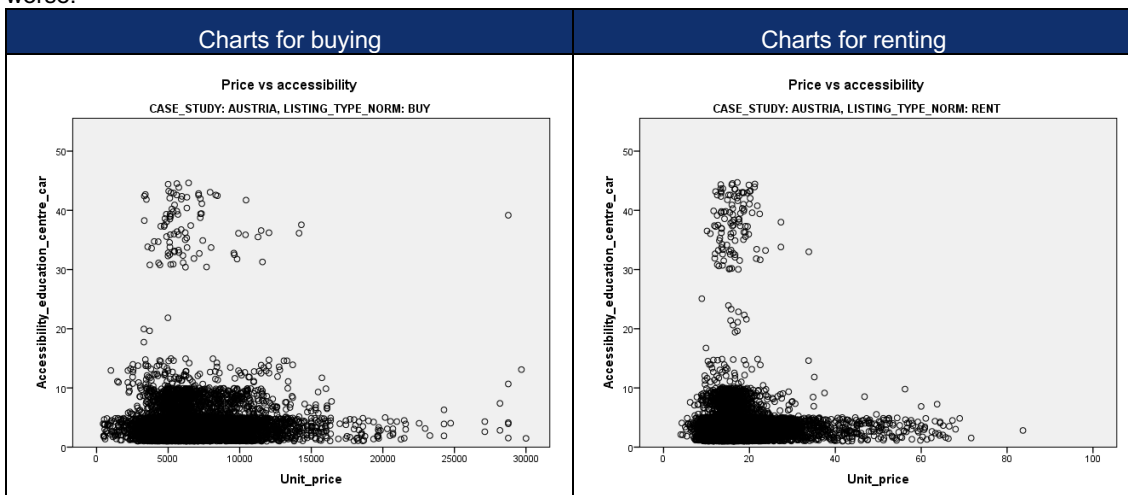
AUSTRIA, BUY

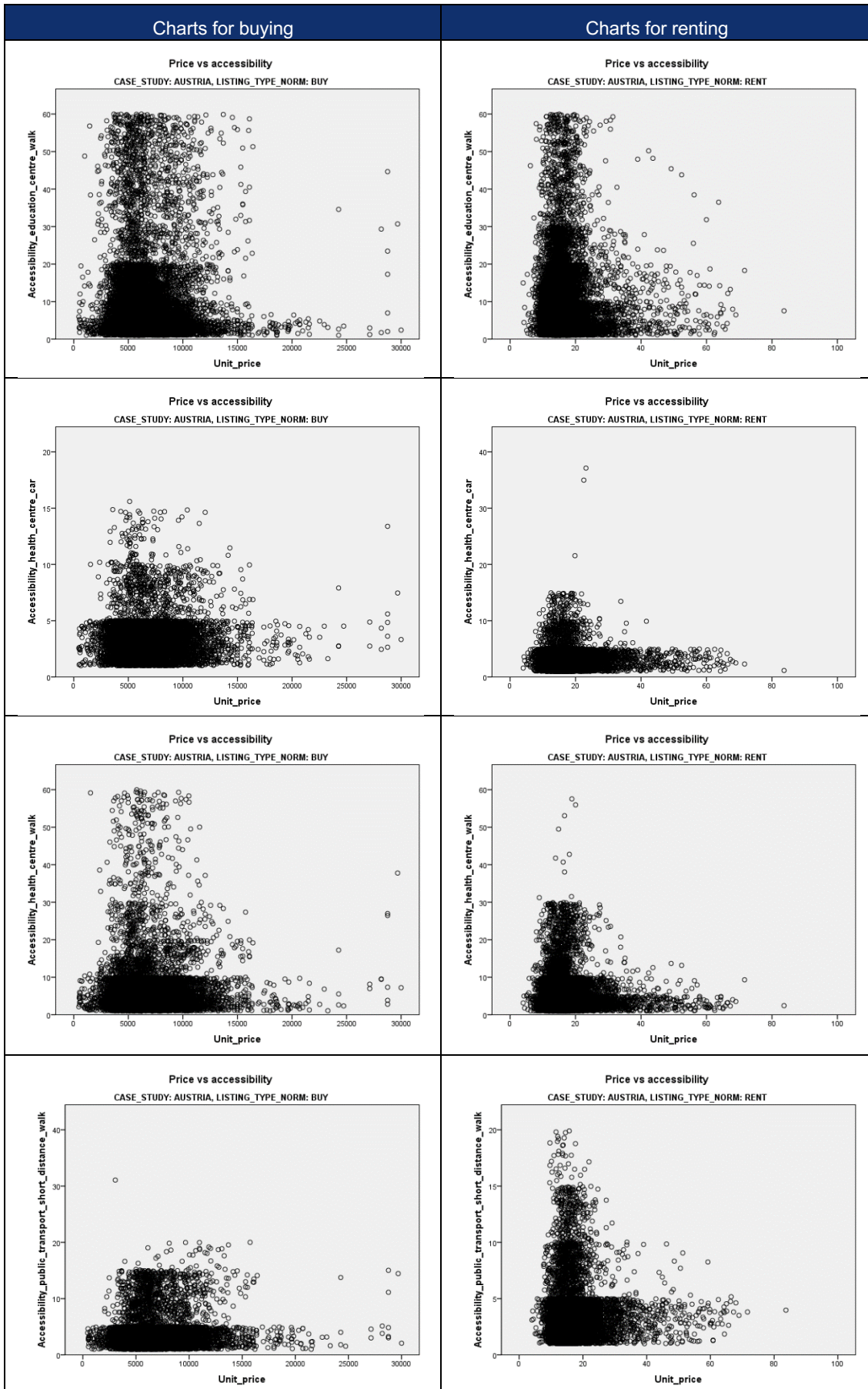
Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	,009	,018	,044	,028	,089	,023	,049	,044
Sig. (2-tailed)	,363	,078	,000	,005	,000	,021	,000	,000
N	10044	10044	10044	10044	10044	10044	10044	10044

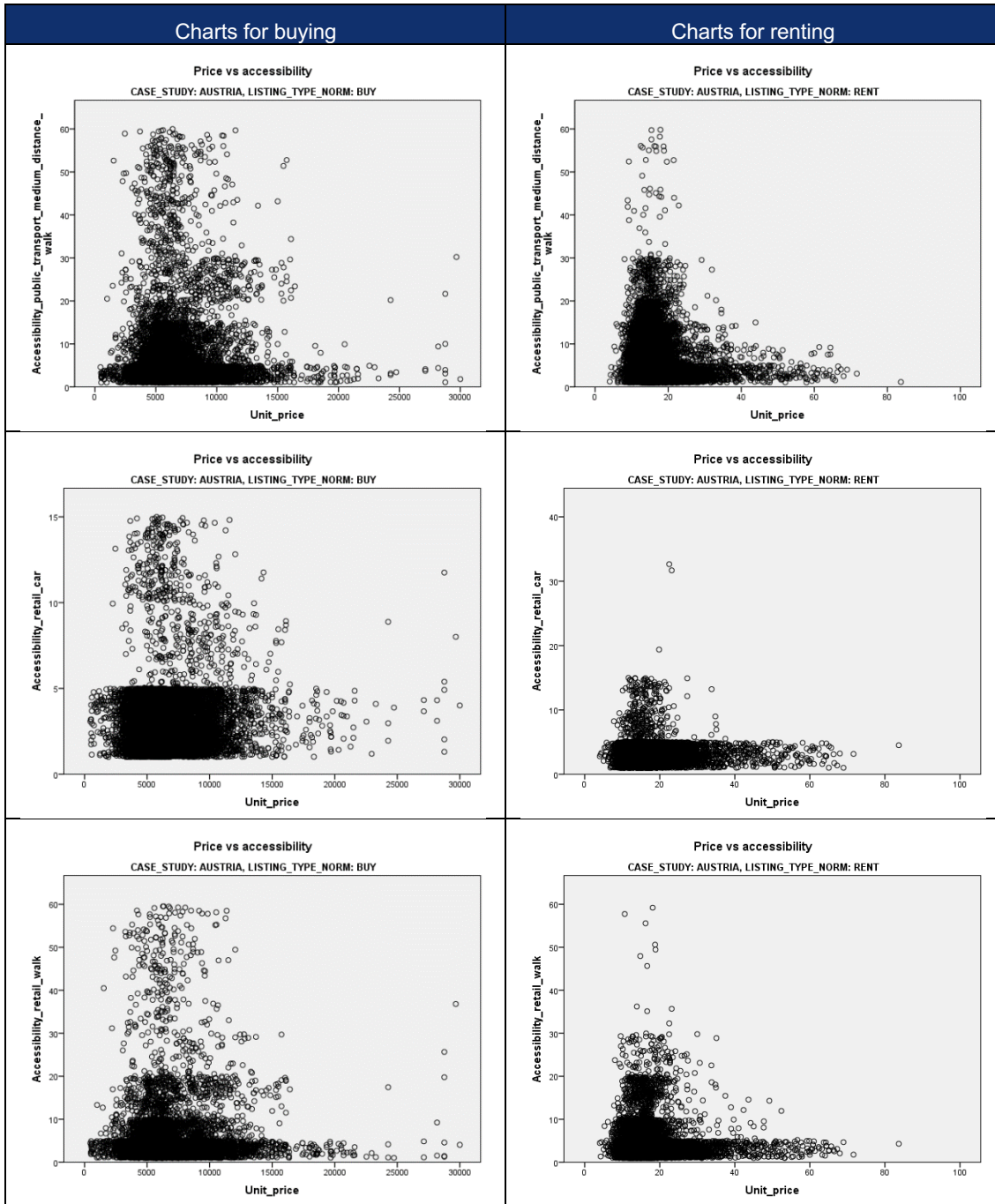
AUSTRIA, RENT

Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	-,009	-,011	-,012	-,051	-,014	-,055	-,001	-,013
Sig. (2-tailed)	,297	,216	,164	,000	,097	,000	,881	,130
N	13271	13271	13271	13271	13271	13271	13271	13271

The correlation values for the Austrian municipalities are very low indicating no significant correlation at all. In fact, the values for buying are positive, indicating that price gets slightly higher when accessibility gets worse.







2.2 Bulgaria

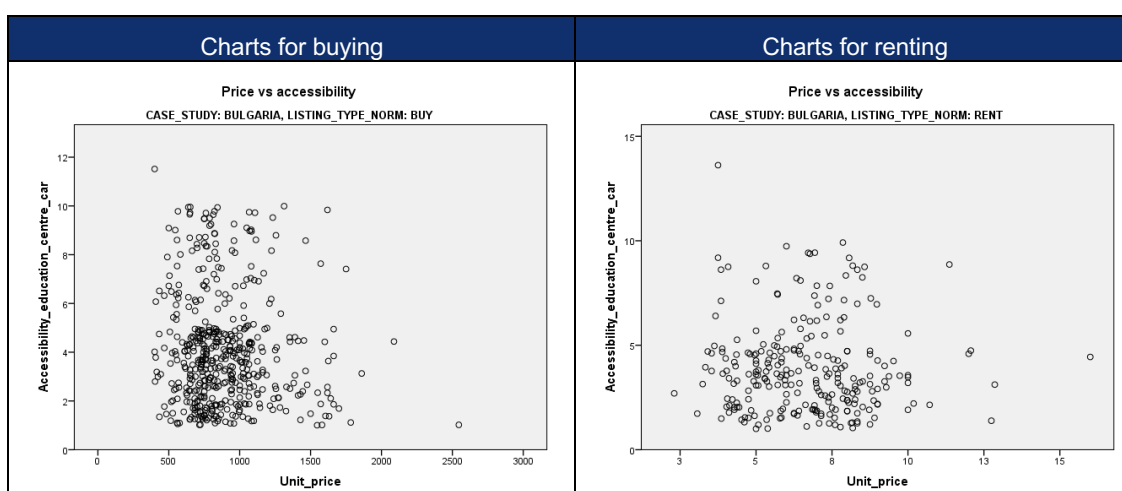
BULGARIA, BUY

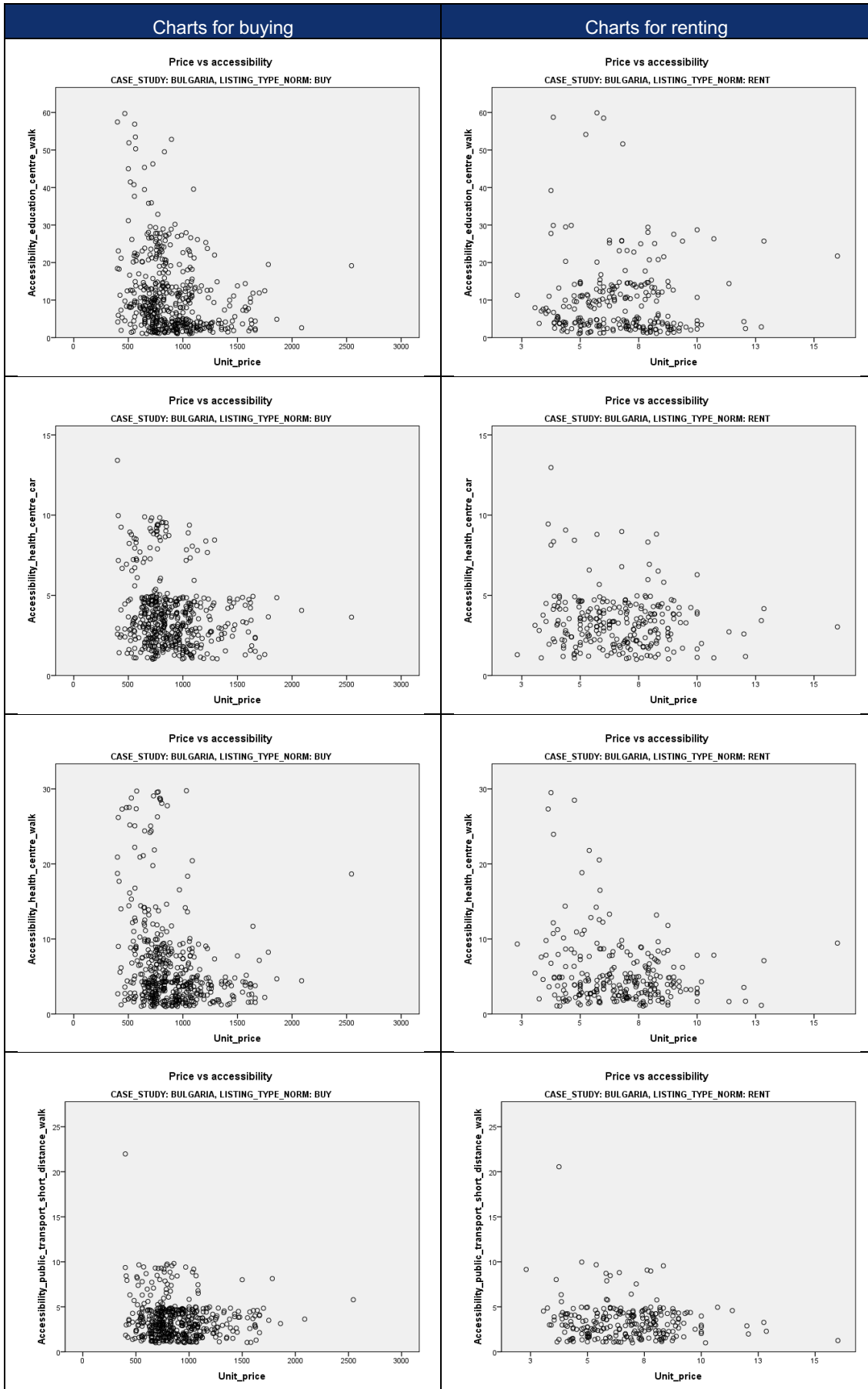
Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	-,086	-,242	-,165	-,253	-,085	-,192	-,048	-,210
Sig. (2-tailed)	,057	,000	,000	,000	,059	,000	,294	,000
N	490	490	490	490	490	490	490	490

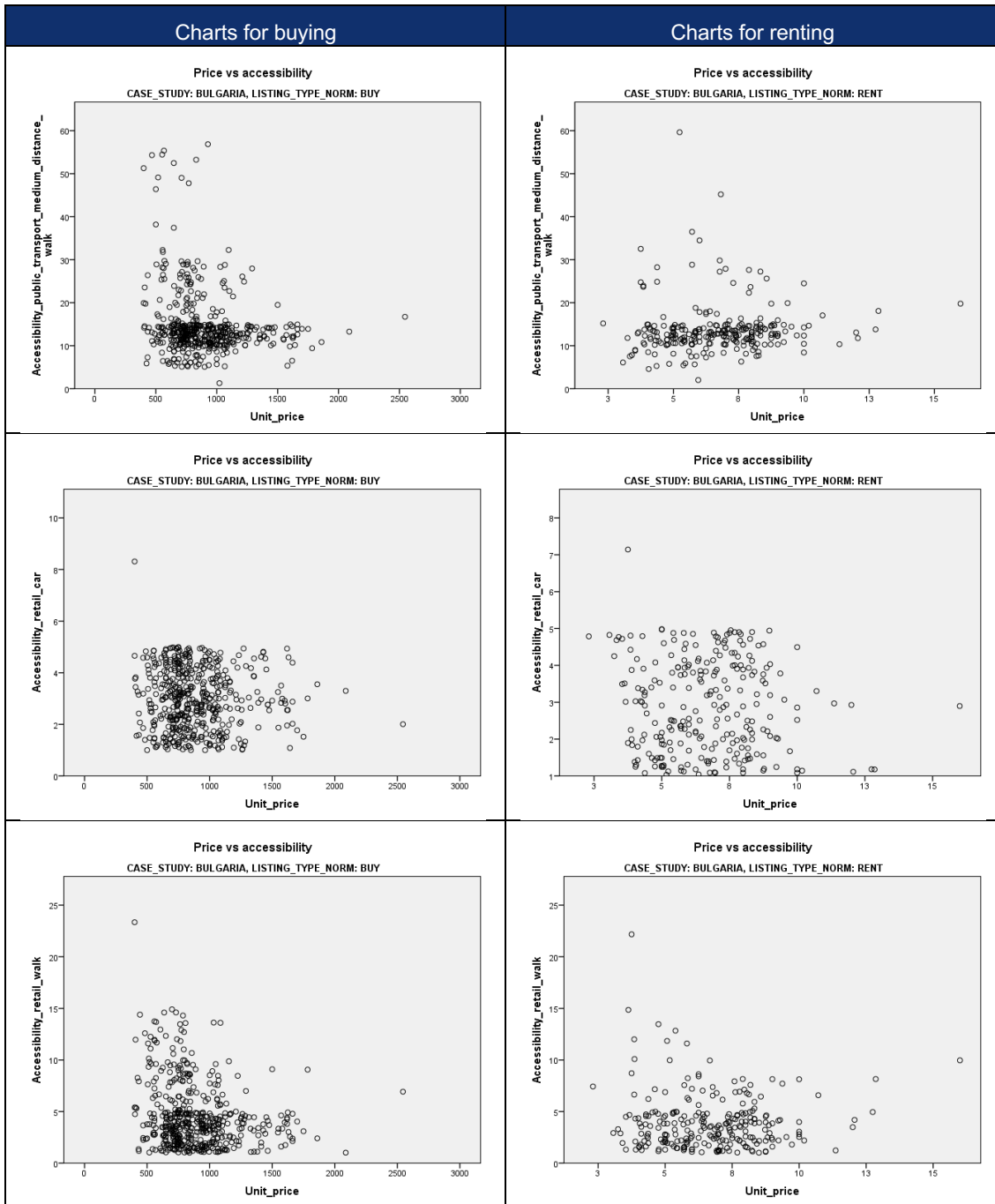
BULGARIA, RENT

Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	-,030	-,022	-,116	-,212	-,124	,051	-,082	-,048
Sig. (2-tailed)	,640	,731	,066	,001	,048	,417	,195	,443
N	254	254	254	254	254	254	254	254

The correlation values for the Bulgarian municipalities are very low indicating no significant correlation at all. Correlation values are negative indicating that at least the price gets higher when accessibility improves, but not in a very significant way.







2.3 France (Haut Savoie)

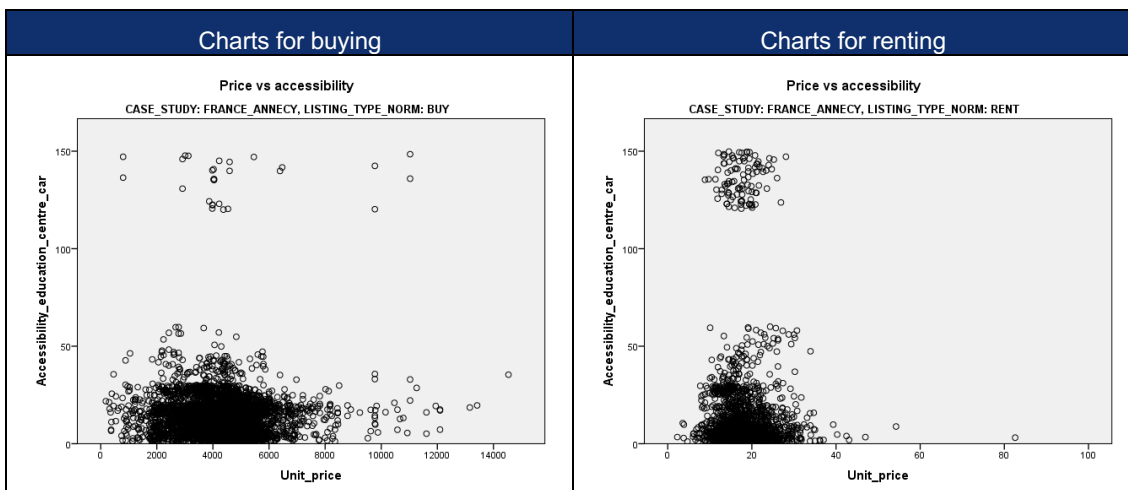
FRANCE_ANNECY, BUY

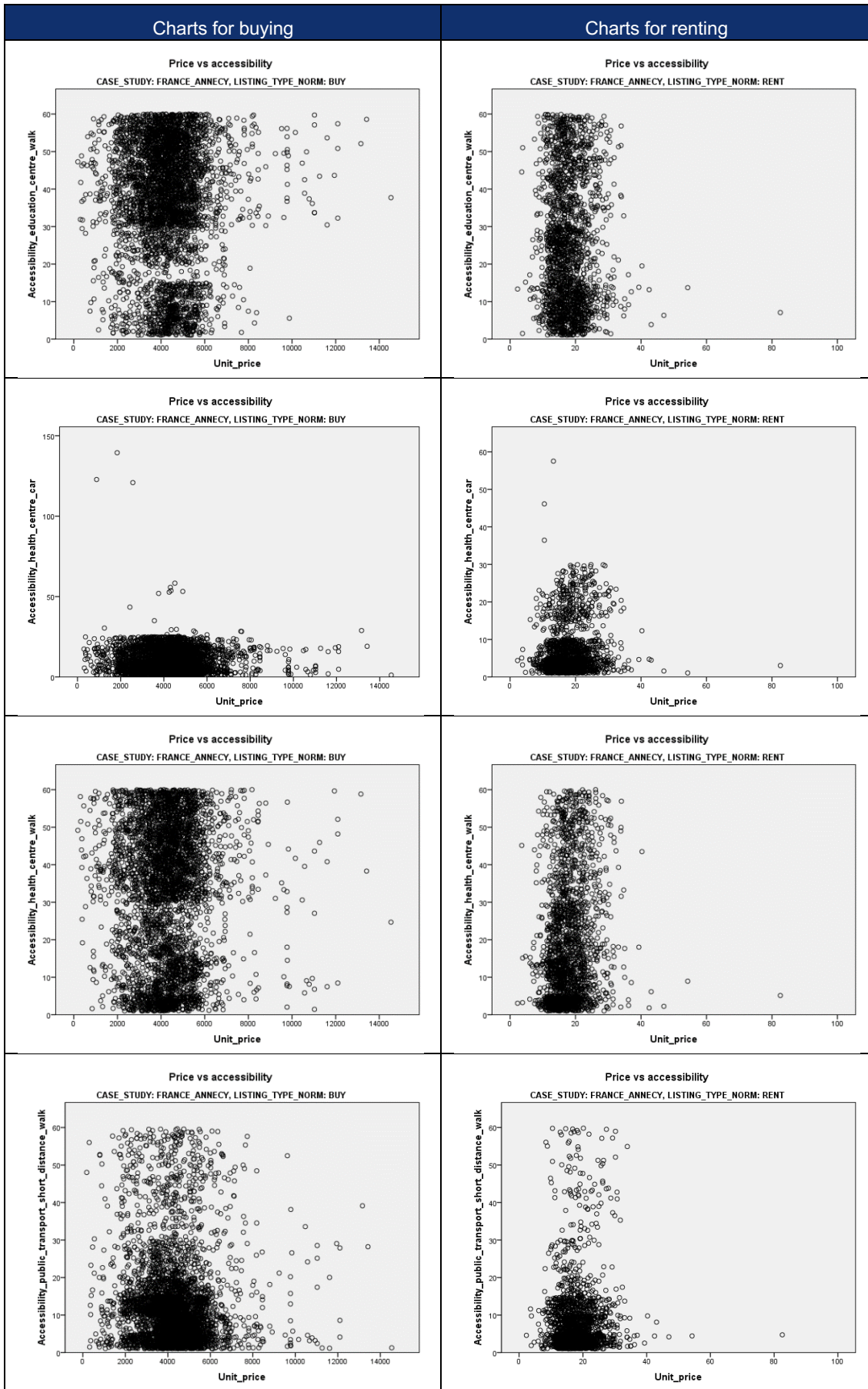
Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	-,025	-,005	-,033	,000	-,066	-,116	-,087	,004
Sig. (2-tailed)	,104	,763	,036	,997	,000	,000	,000	,798
N	4101	4101	4080	4101	4101	4101	4101	4101

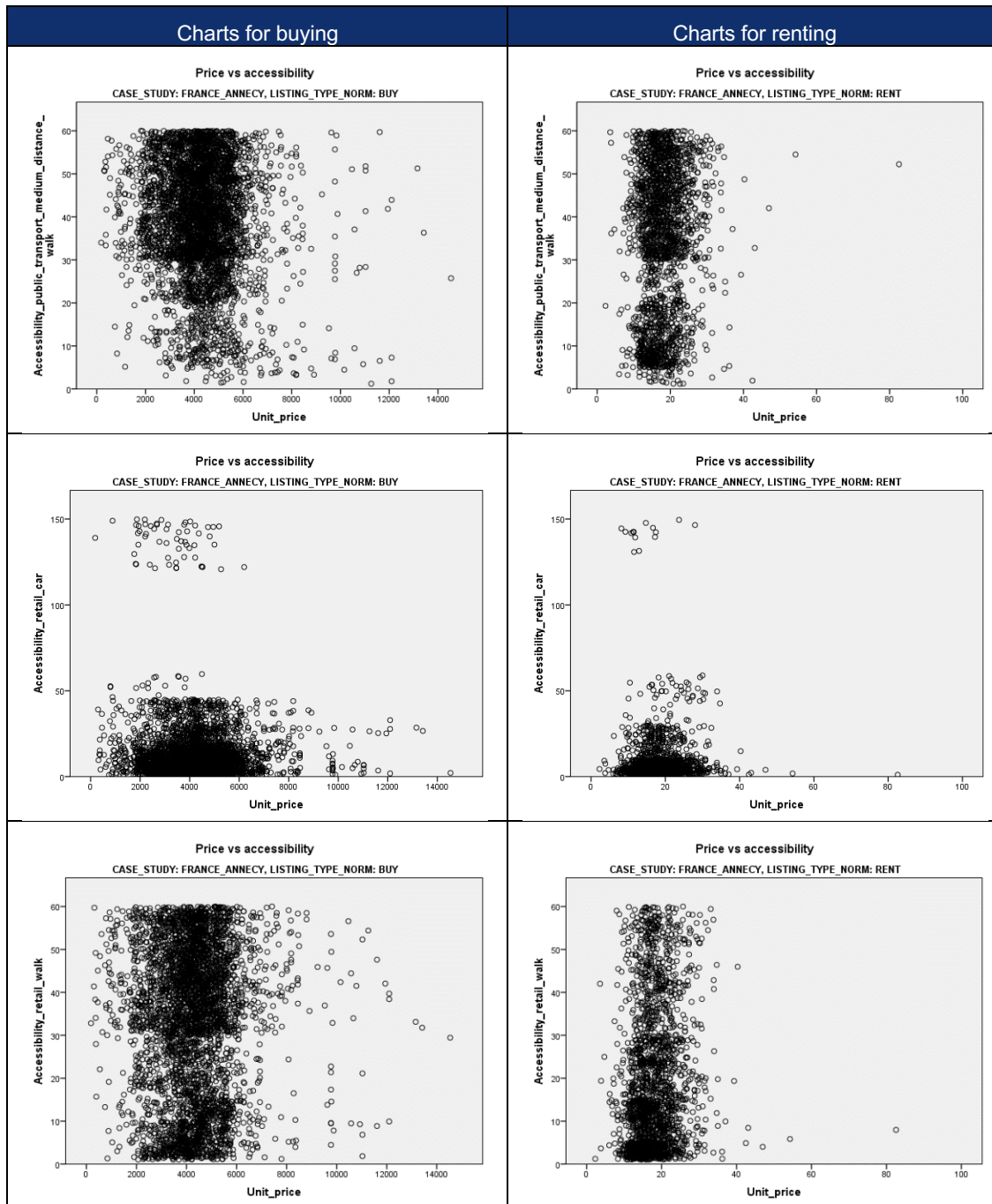
FRANCE_ANNECY, RENT

Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	-,020	-,009	,122	,139	,045	,105	,040	,124
Sig. (2-tailed)	,363	,682	,000	,000	,044	,000	,074	,000
N	2011	2011	2009	2011	2011	2011	2011	2011

The correlation values for the French municipalities bordering Switzerland are very low indicating no significant correlation at all. Correlation values are negative indicating that at least the price gets higher when accessibility improves, but not in a very significant way.







2.4 France (Pyrénées-Atlantiques)

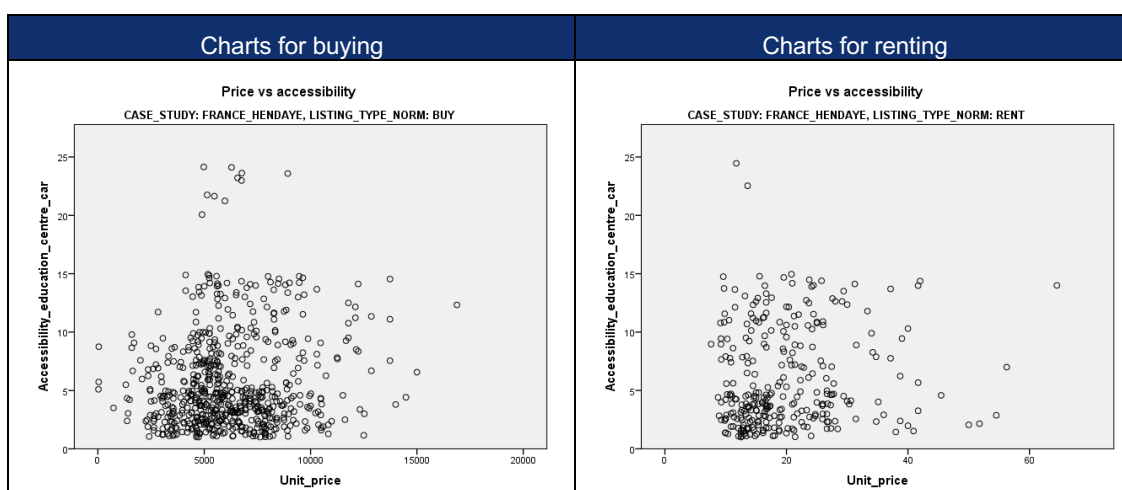
FRANCE_HENDAYE, BUY

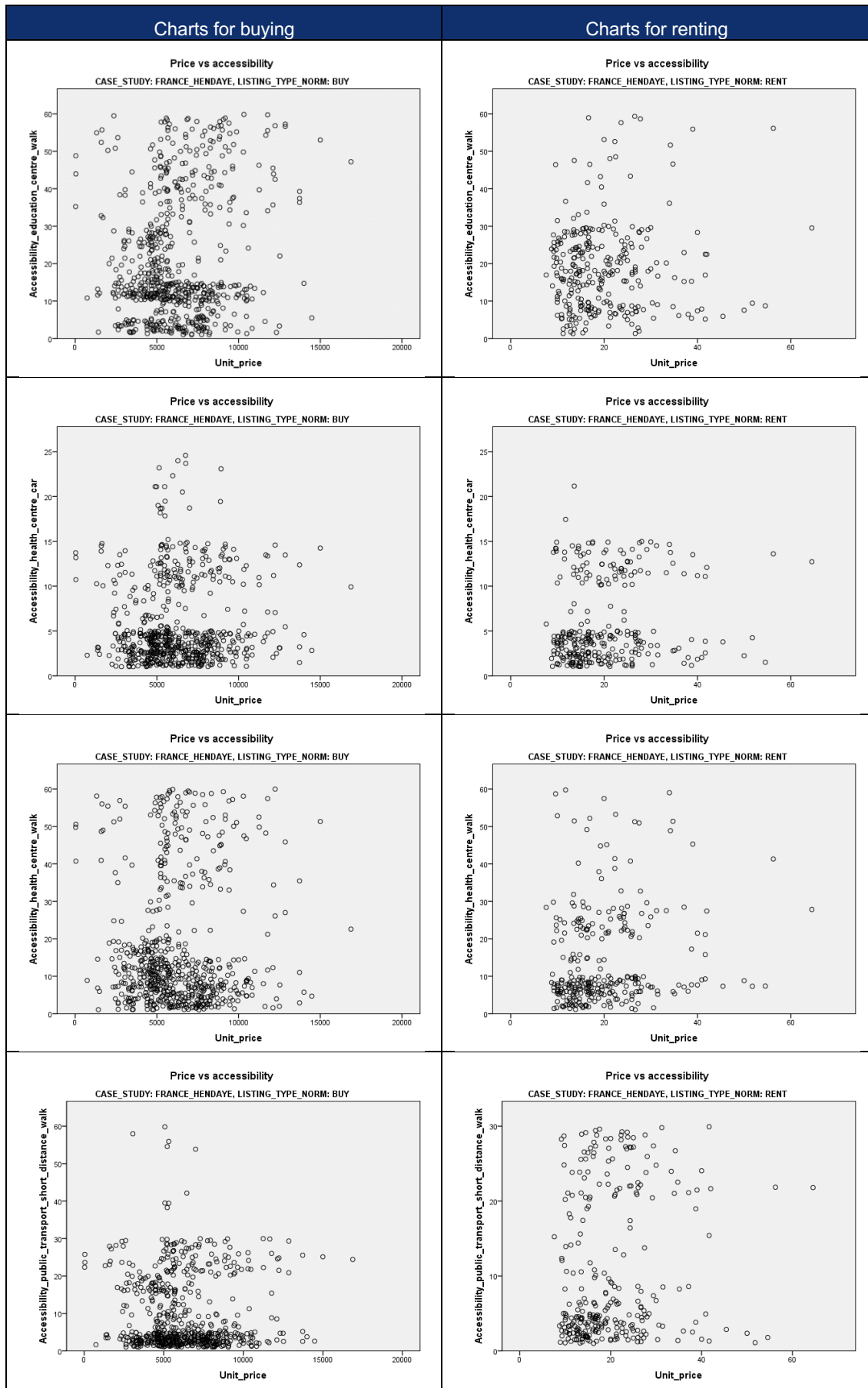
Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	,120	,161	,052	,034	-,025	-,004	,080	-,017
Sig. (2-tailed)	,002	,000	,190	,390	,527	,922	,043	,669
N	642	642	642	642	642	642	642	642

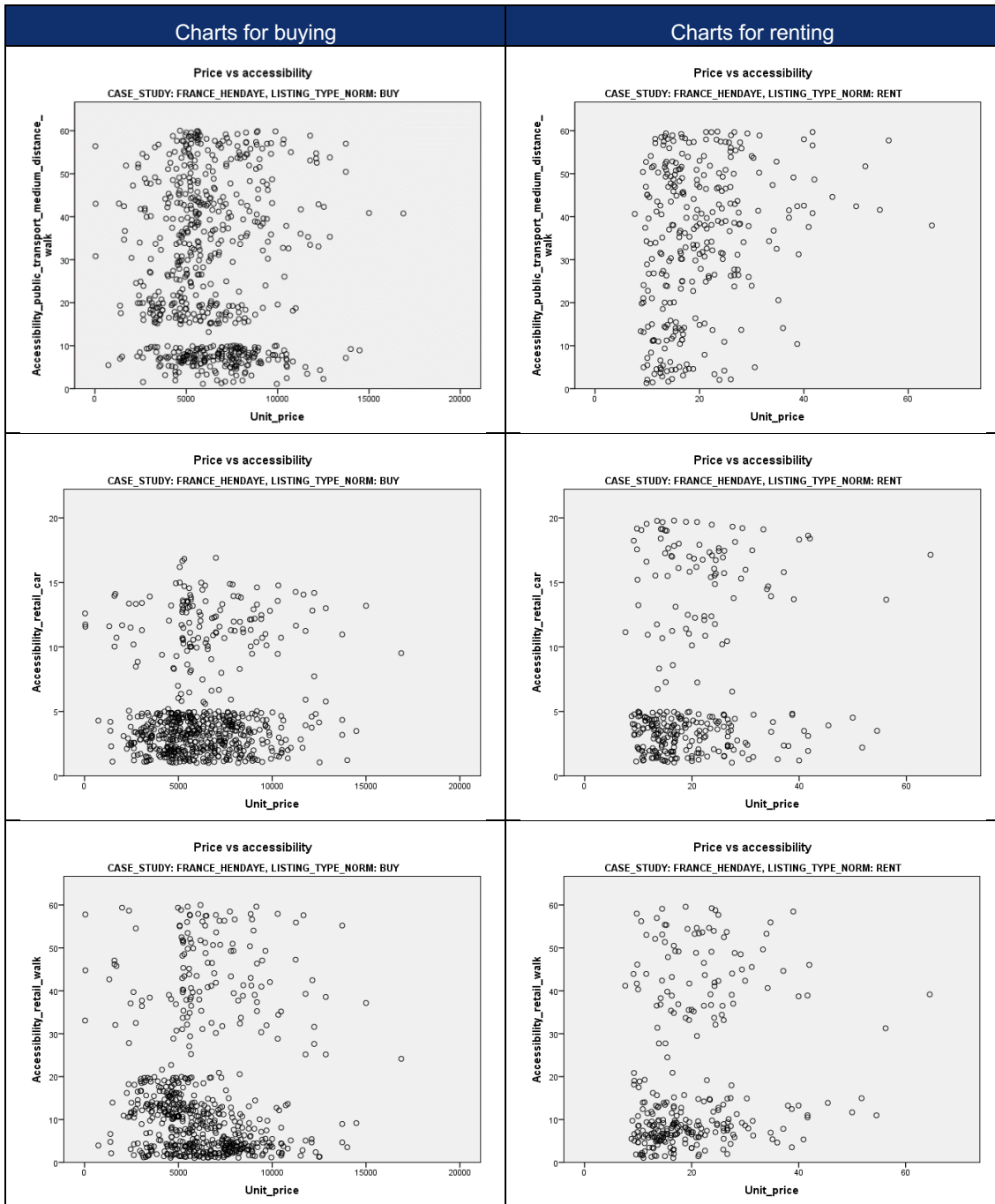
FRANCE_HENDAYE, RENT

Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	,090	,060	,134	,152	,137	,252	,152	,168
Sig. (2-tailed)	,121	,304	,021	,009	,018	,000	,009	,004
N	295	295	295	295	295	295	295	295

The correlation values for the French municipalities bordering Spain are very low indicating no significant correlation at all. In fact correlation is always positive indicating that prices increase when accessibility gets worse.







2.5 Republic of Ireland

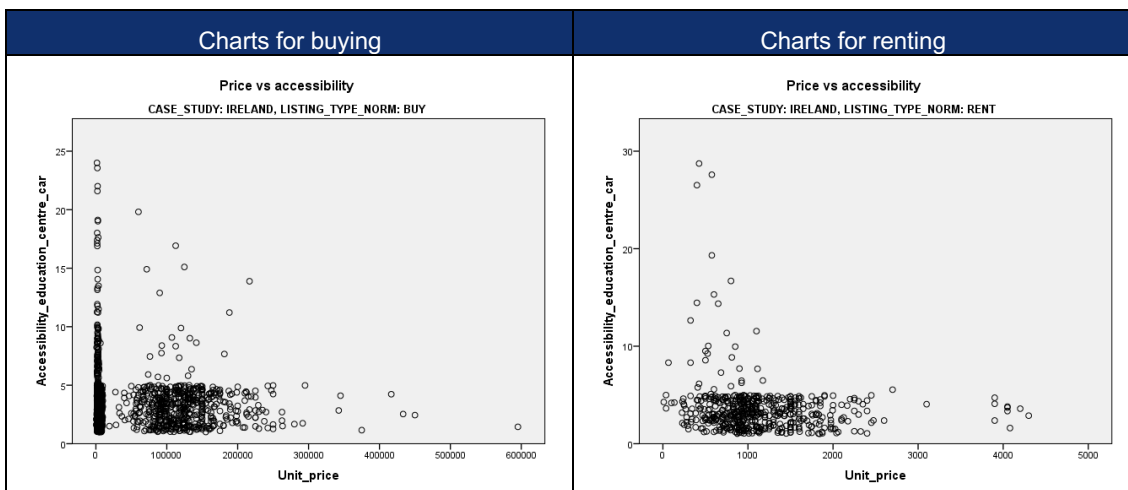
IRELAND, BUY

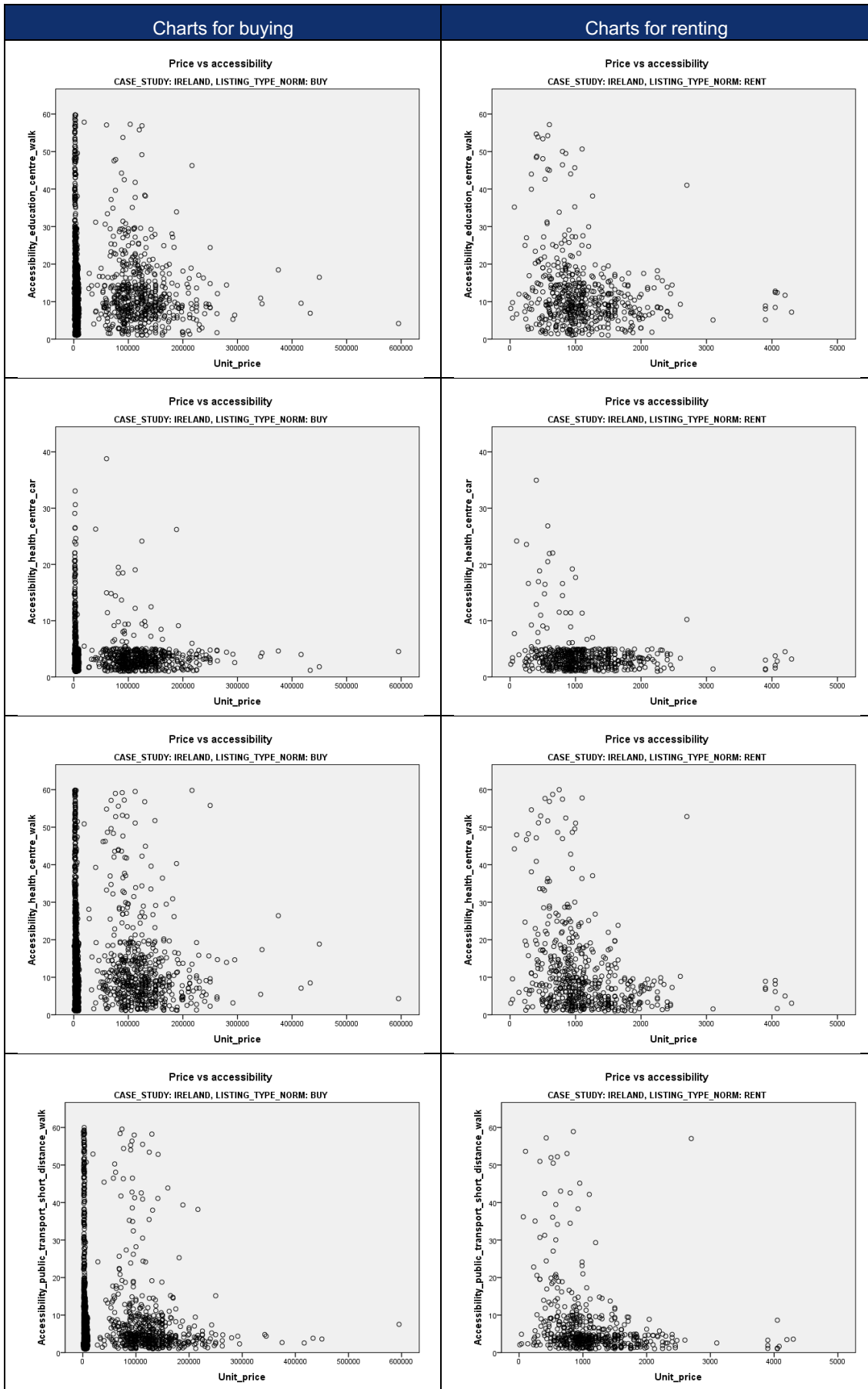
Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	-,023	-,029	-,031	-,046	-,050	,025	-,028	-,022
Sig. (2-tailed)	,267	,159	,134	,025	,015	,224	,170	,293
N	2364	2364	2364	2364	2364	2364	2364	2364

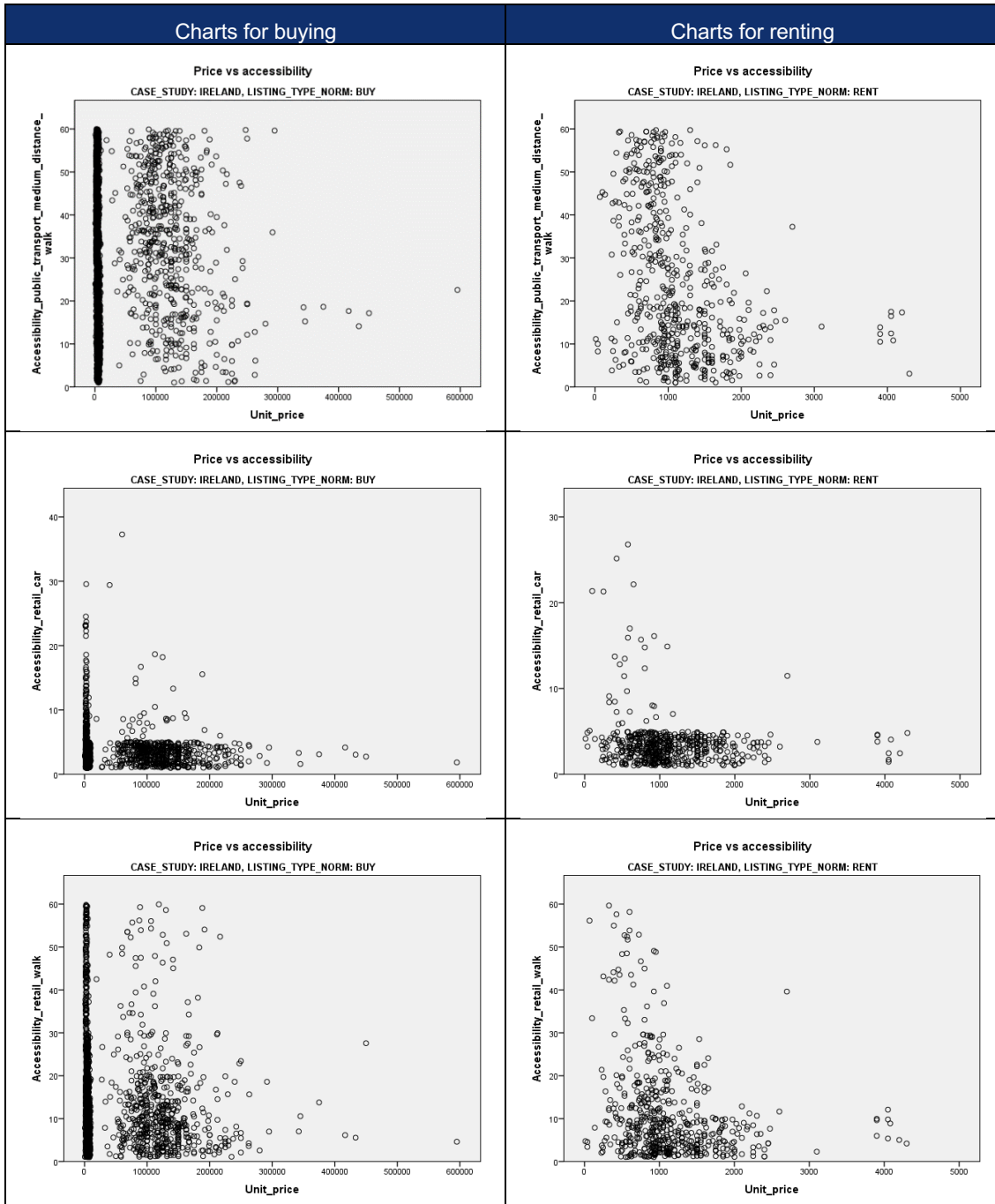
IRELAND, RENT

Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	-,154	-,191	-,190	-,273	-,255	-,342	-,139	-,262
Sig. (2-tailed)	,000	,000	,000	,000	,000	,000	,001	,000
N	534	534	534	534	534	534	534	534

The correlation values for the Irish municipalities are very low indicating no significant correlation at all. Correlation values are negative indicating that at least the price gets higher when accessibility improves, but not in a very significant way.







2.6 Northern Ireland

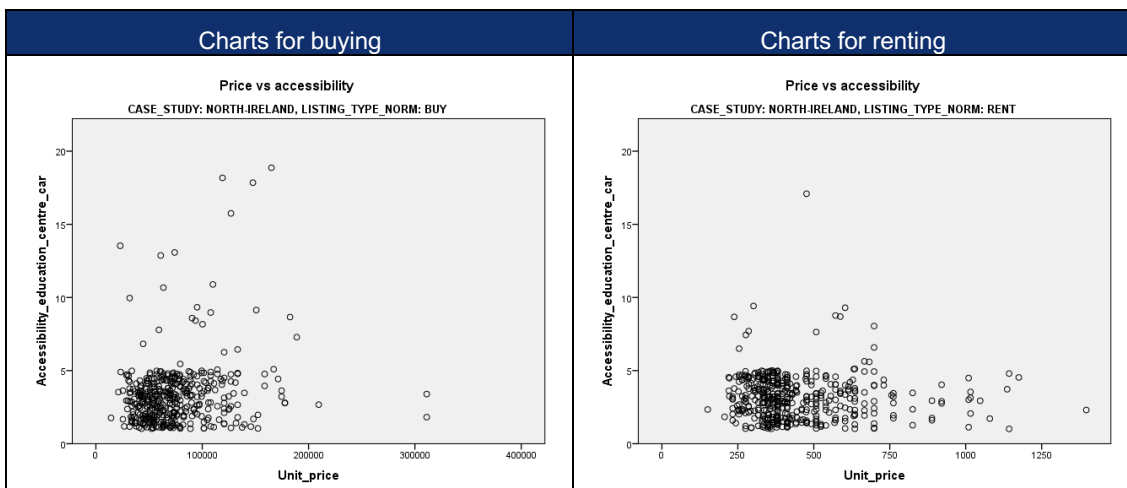
NORTH-IRELAND, BUY

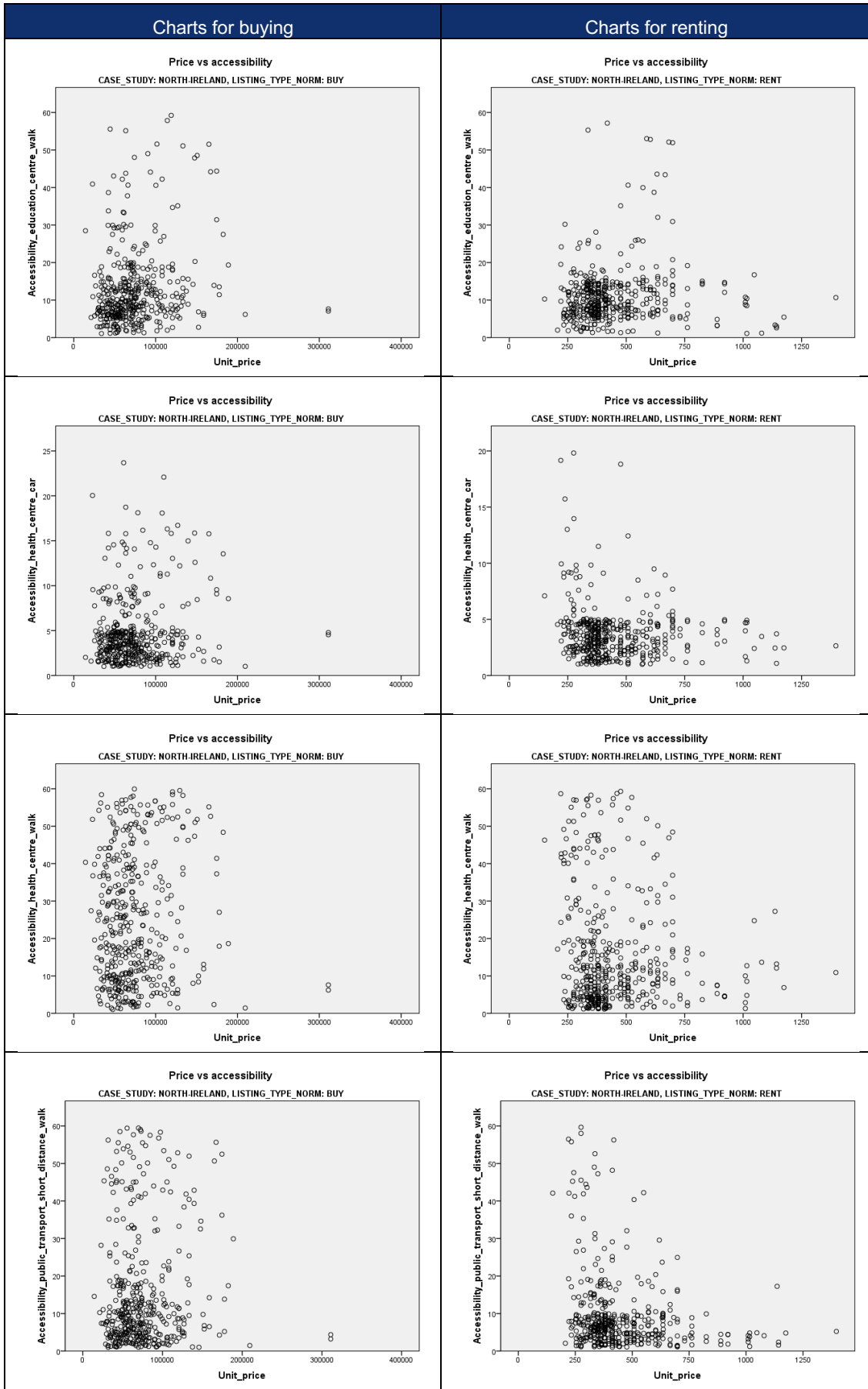
Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	,194	,185	,118	,053	,056	-,077	,175	,016
Sig. (2-tailed)	,000	,000	,016	,277	,249	,114	,000	,748
N	422	422	422	422	422	422	422	422

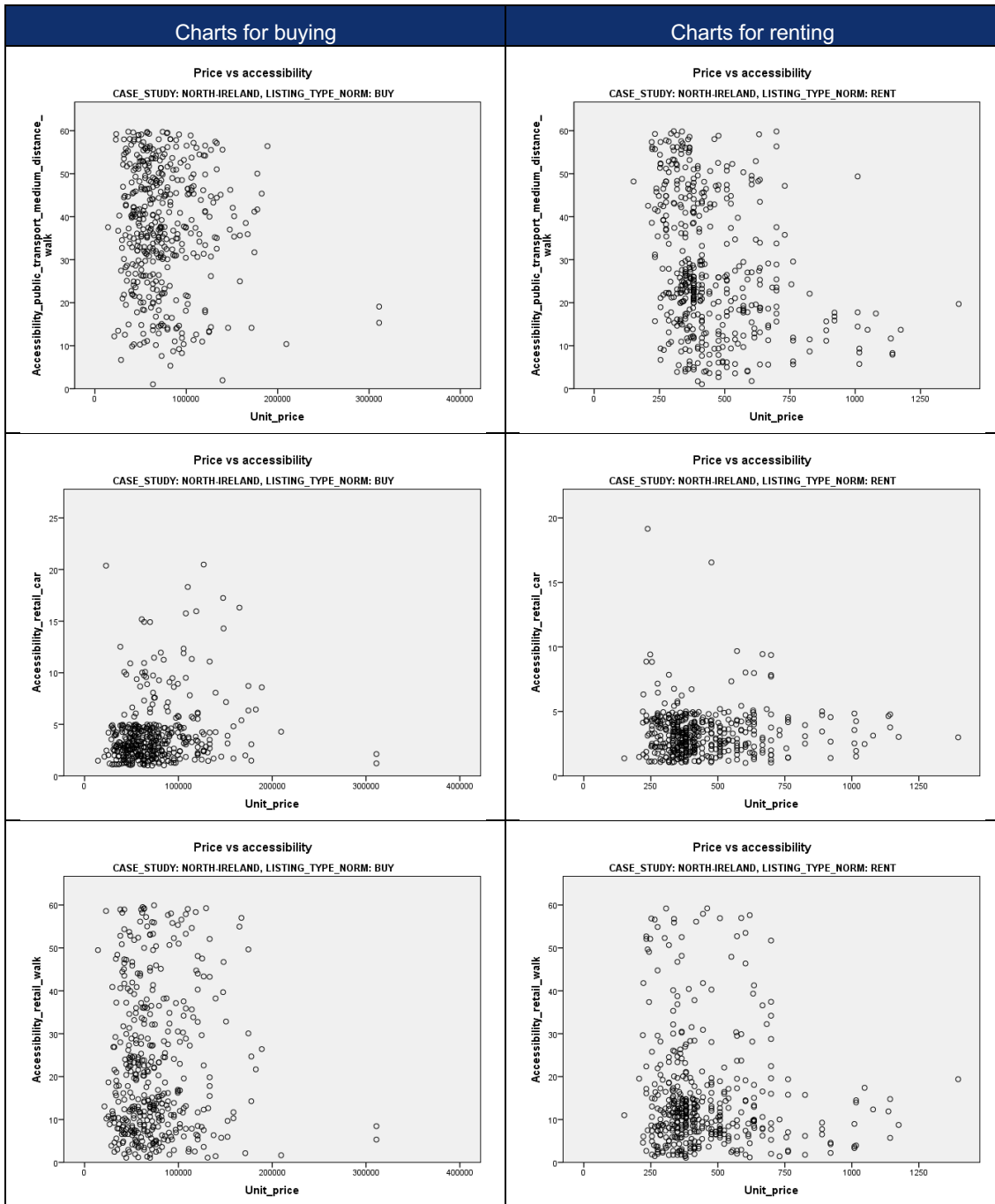
NORTH-IRELAND, RENT

Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	-,045	,089	-,120	-,100	-,227	-,298	,010	-,085
Sig. (2-tailed)	,348	,060	,011	,035	,000	,000	,830	,073
N	446	446	446	446	446	446	446	446

The correlation values for the Northern Ireland municipalities are very low indicating no significant correlation at all. Correlation values are negative indicating that at least the price gets higher when accessibility improves, but not in a very significant way.







2.7 Romania

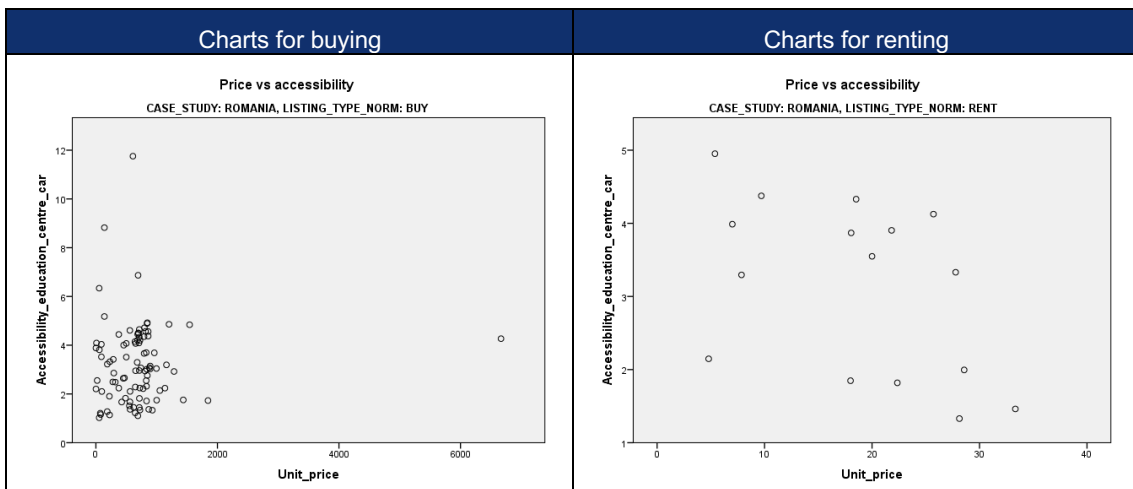
ROMANIA, BUY

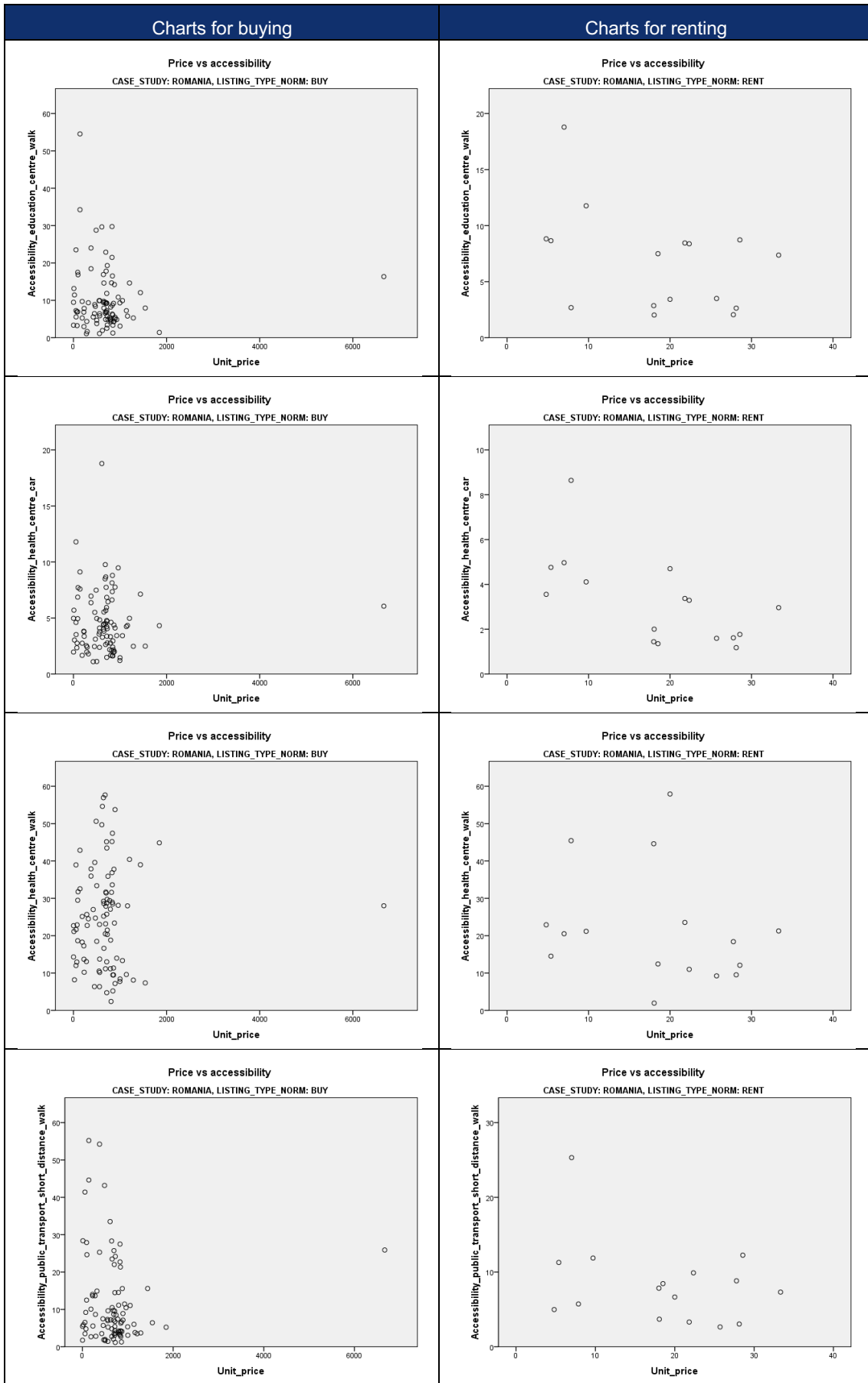
Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	,049	-,020	,023	,049	-,022	,032	-,066	-,008
Sig. (2-tailed)	,641	,846	,825	,638	,832	,762	,528	,940
N	94	94	94	94	94	94	94	94

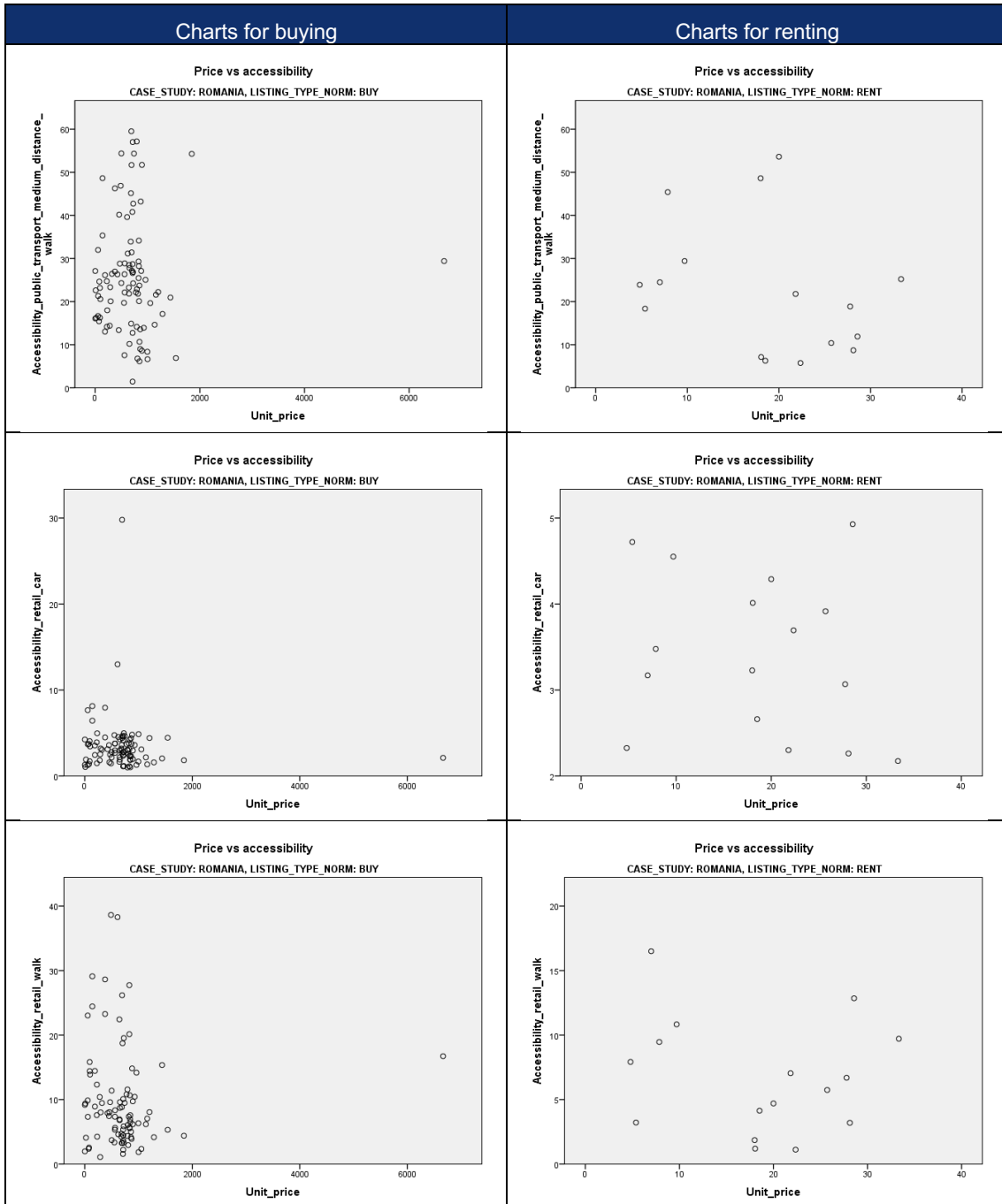
ROMANIA, RENT

Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	-,484	-,419	-,633	-,230	-,349	-,304	-,200	-,168
Sig. (2-tailed)	,057	,106	,009	,391	,185	,252	,458	,533
N	16	16	16	16	16	16	16	16

The correlation values for the Romanian municipalities are very low indicating no significant correlation at all. Correlation values are negative indicating that at least the price gets higher when accessibility improves, but not in a very significant way. Moreover, the amount of valid points for the correlation is very low, so no statistical significance can be expected from this result.







2.8 Slovakia

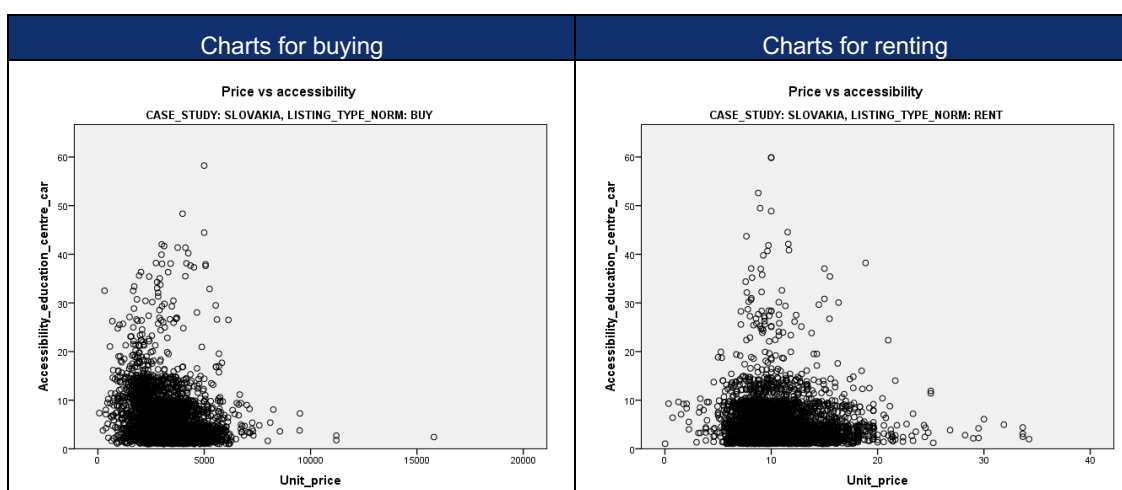
SLOVAKIA, BUY

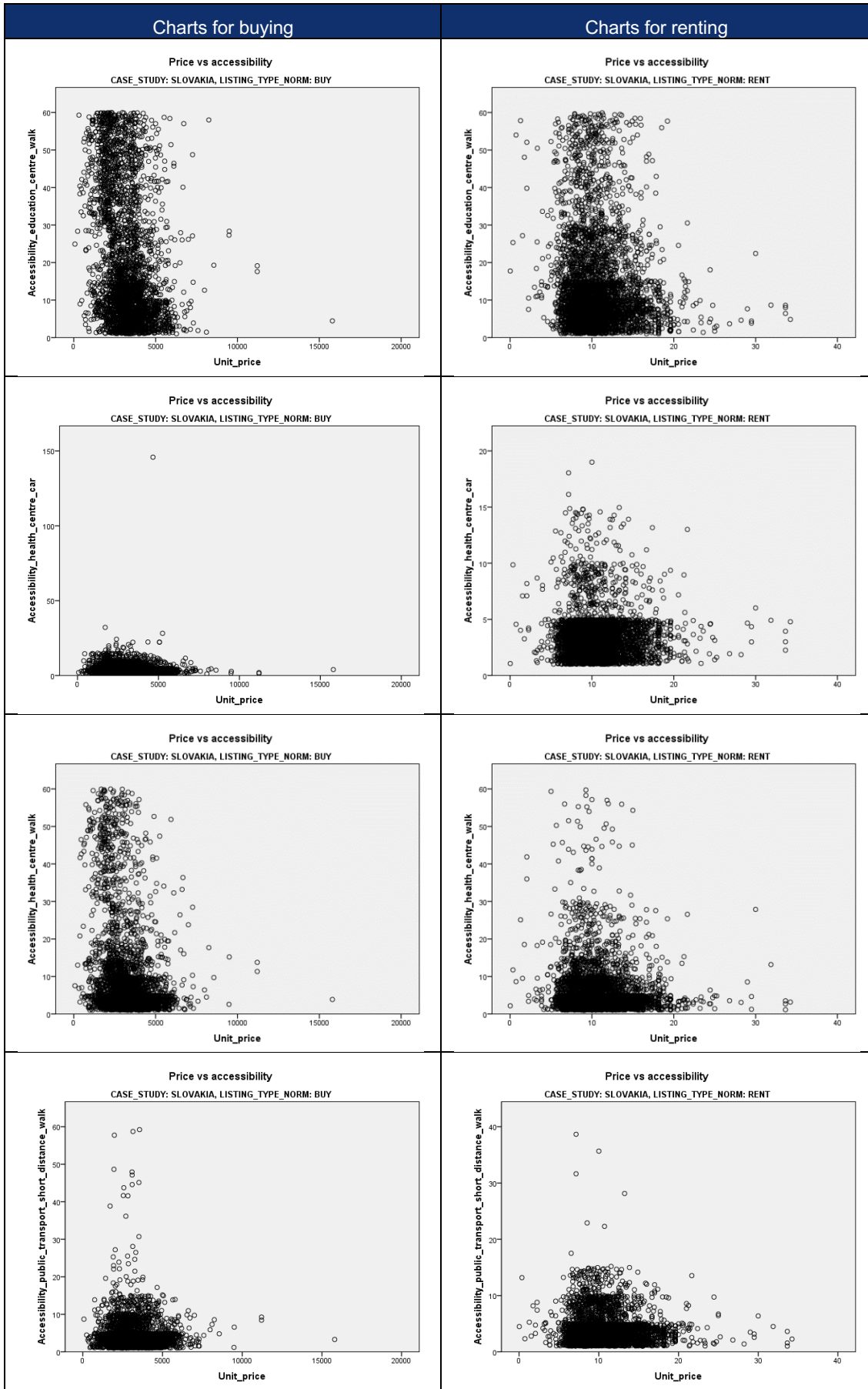
Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	-,216	-,306	-,079	-,274	-,051	-,267	-,118	-,257
Sig. (2-tailed)	,000	,000	,000	,000	,004	,000	,000	,000
N	3170	3170	3170	3170	3170	3170	3170	3170

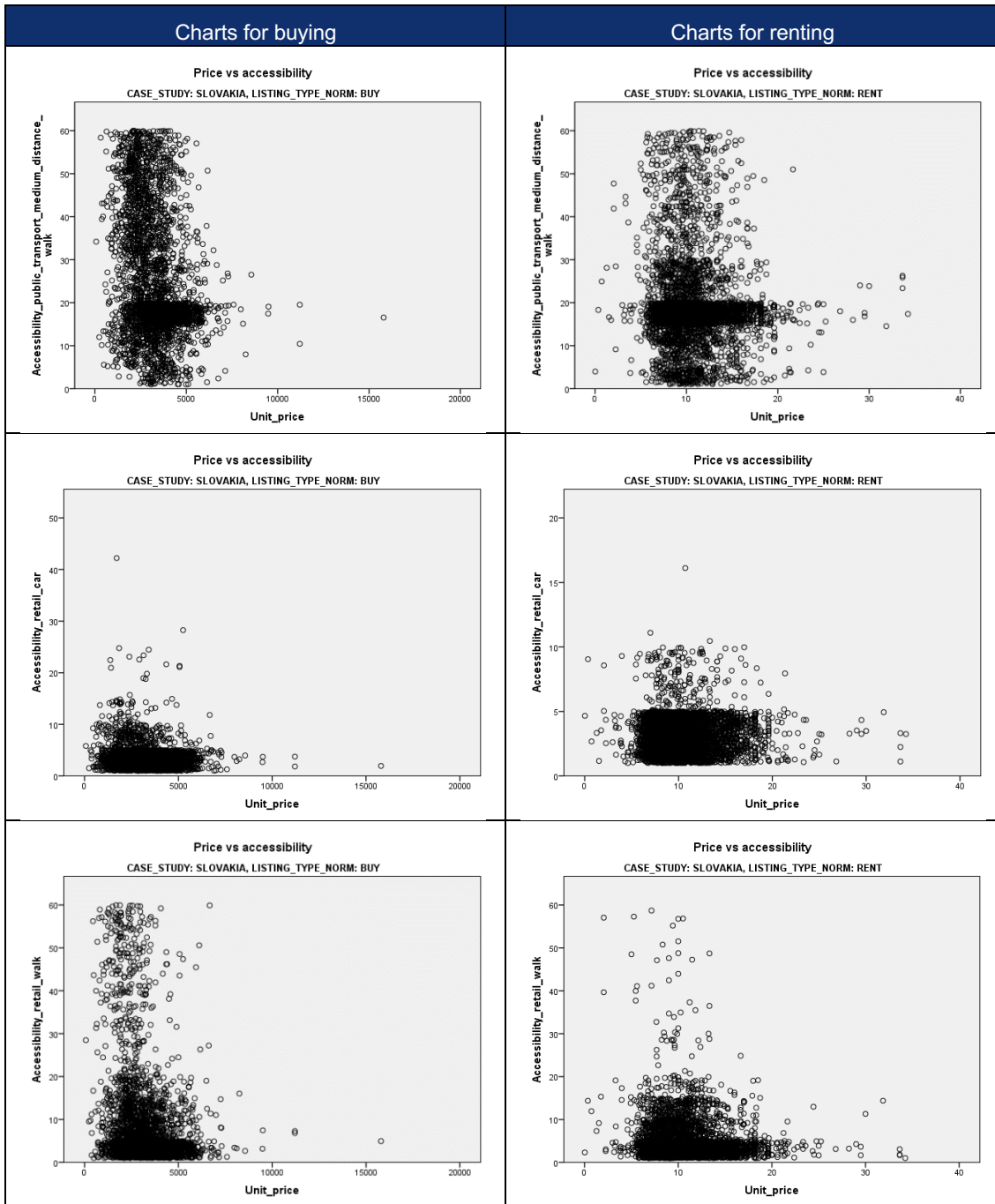
SLOVAKIA, RENT

Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	-,061	-,114	-,030	-,071	-,068	-,074	-,012	-,086
Sig. (2-tailed)	,000	,000	,057	,000	,000	,000	,443	,000
N	3948	3948	3948	3948	3948	3948	3948	3948

The correlation values for the Slovakian municipalities are very low indicating no significant correlation at all. Correlation values are negative indicating that at least the price gets higher when accessibility improves, but not in a very significant way.







2.9 Spain

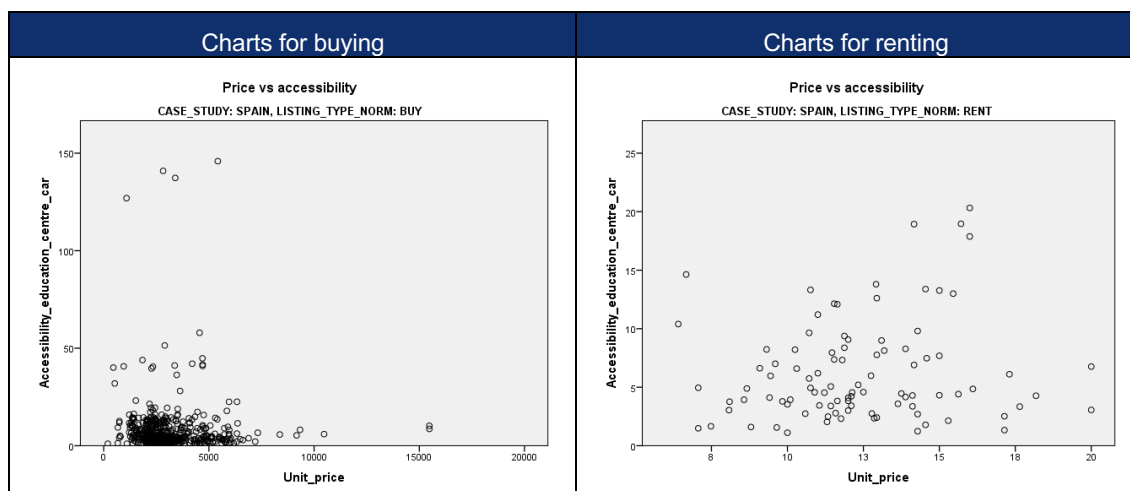
SPAIN, BUY

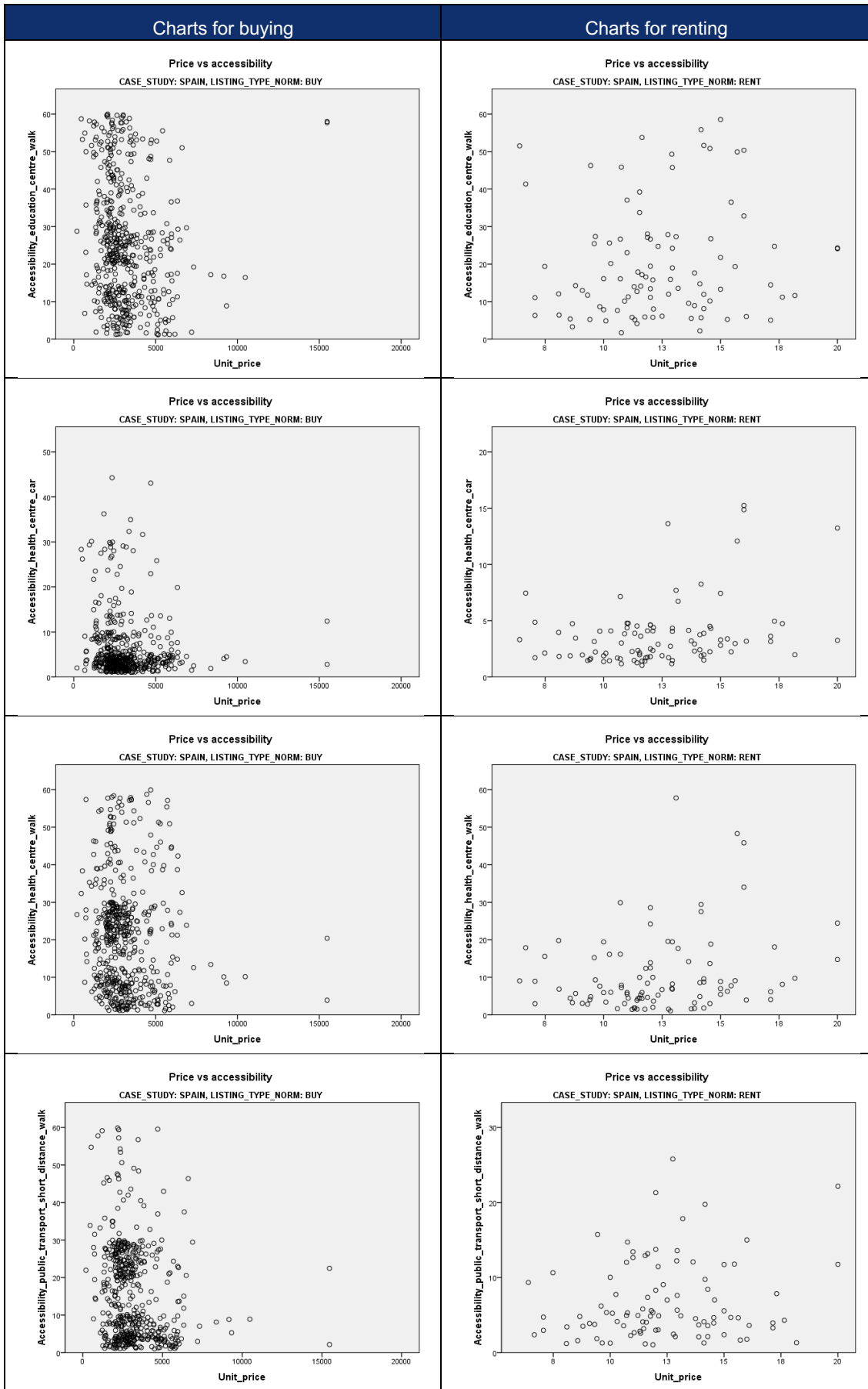
Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	-,016	-,132	-,098	-,083	-,199	-,184	-,007	,001
Sig. (2-tailed)	,713	,003	,027	,062	,000	,000	,868	,988
N	509	509	509	509	509	509	509	509

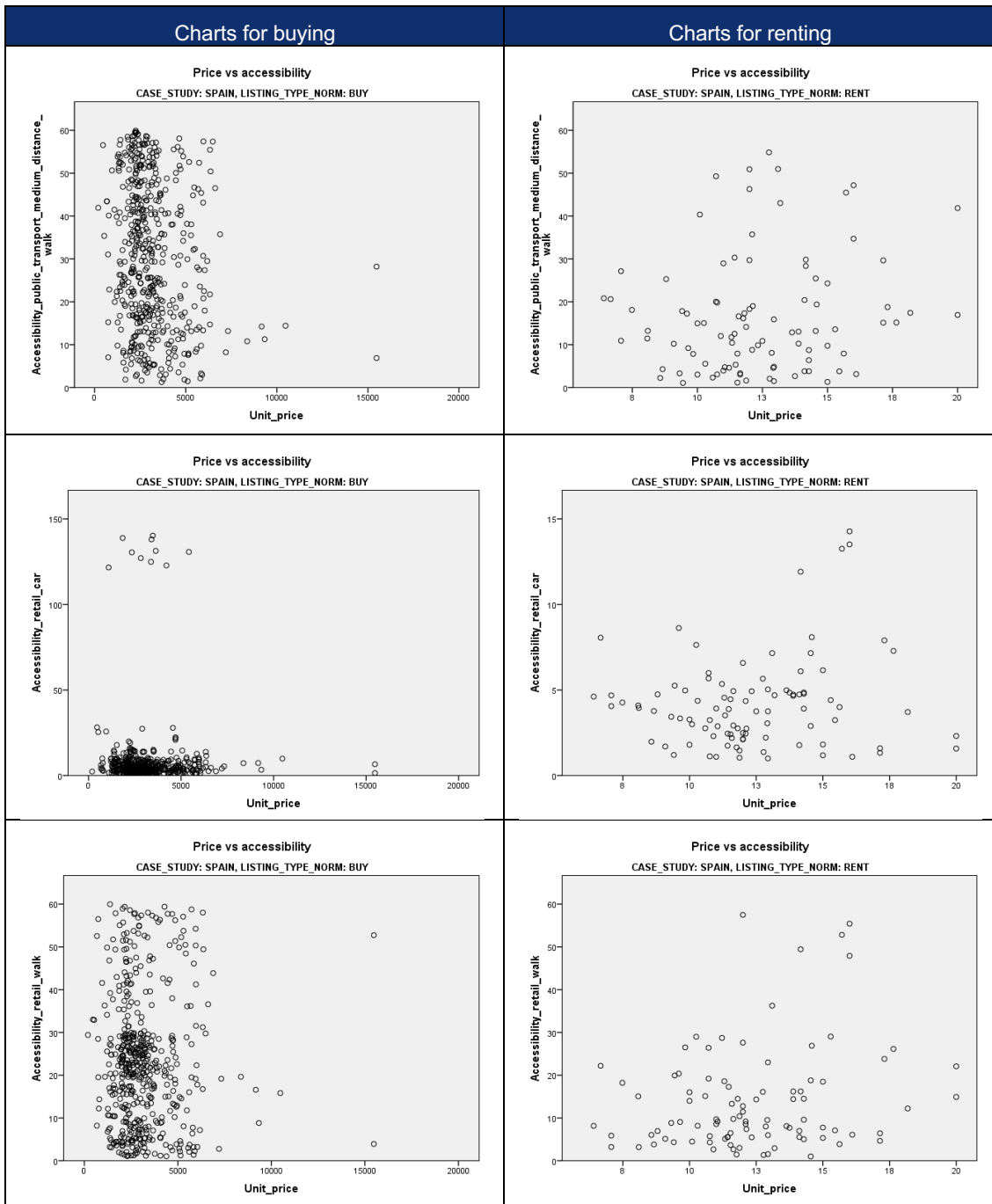
SPAIN, RENT

Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	,133	,102	,320	,222	,149	,159	,136	,223
Sig. (2-tailed)	,199	,325	,002	,031	,148	,125	,189	,030
N	95	95	95	95	95	95	95	95

The correlation values for the Austrian municipalities are very low indicating no significant correlation at all. In fact, the values for renting are positive, indicating that price gets slightly higher when accessibility gets worse.







2.10 Switzerland

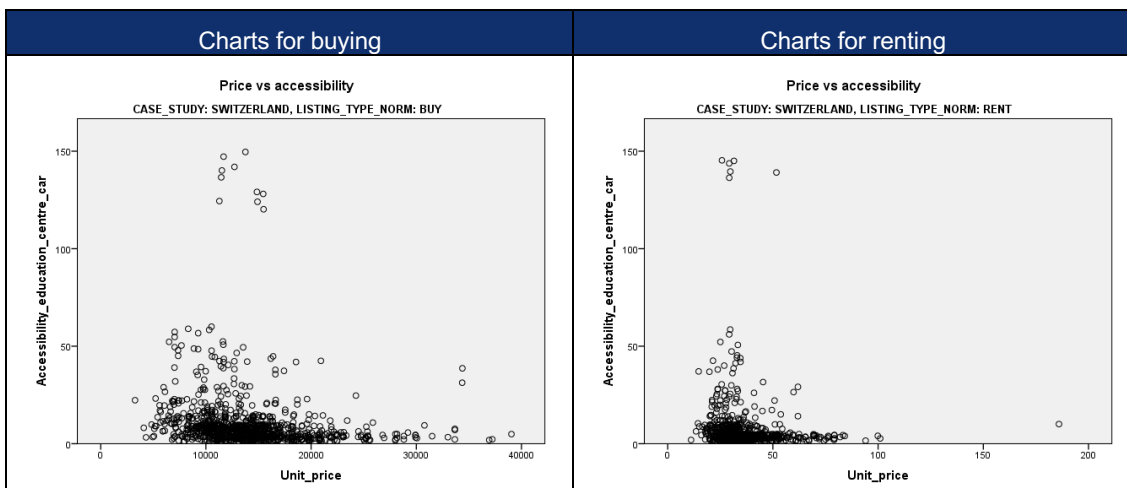
SWITZERLAND, BUY

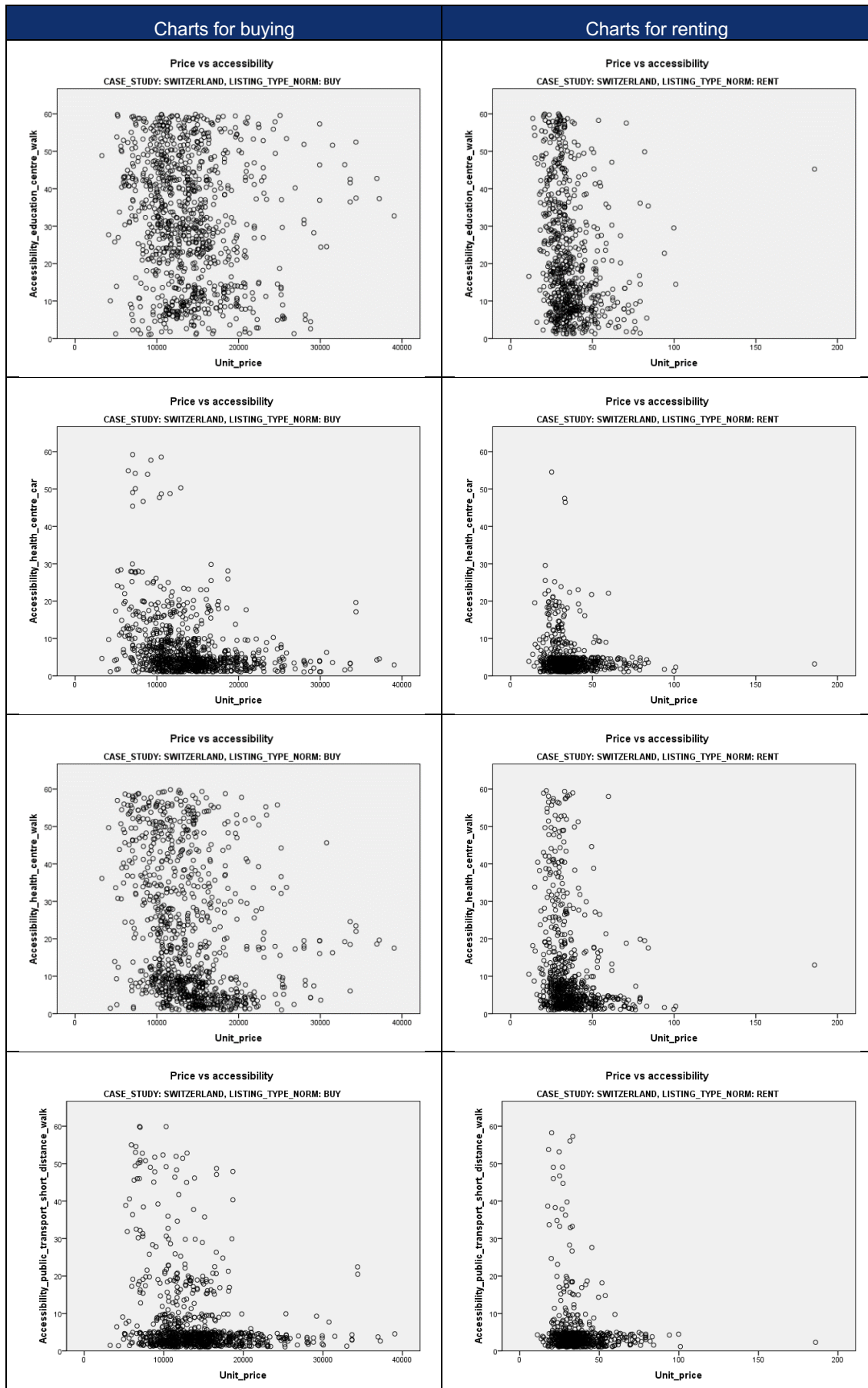
Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	-,162	-,126	-,270	-,261	-,230	-,254	-,199	-,164
Sig. (2-tailed)	,000	,000	,000	,000	,000	,000	,000	,000
N	963	963	963	963	963	963	963	963

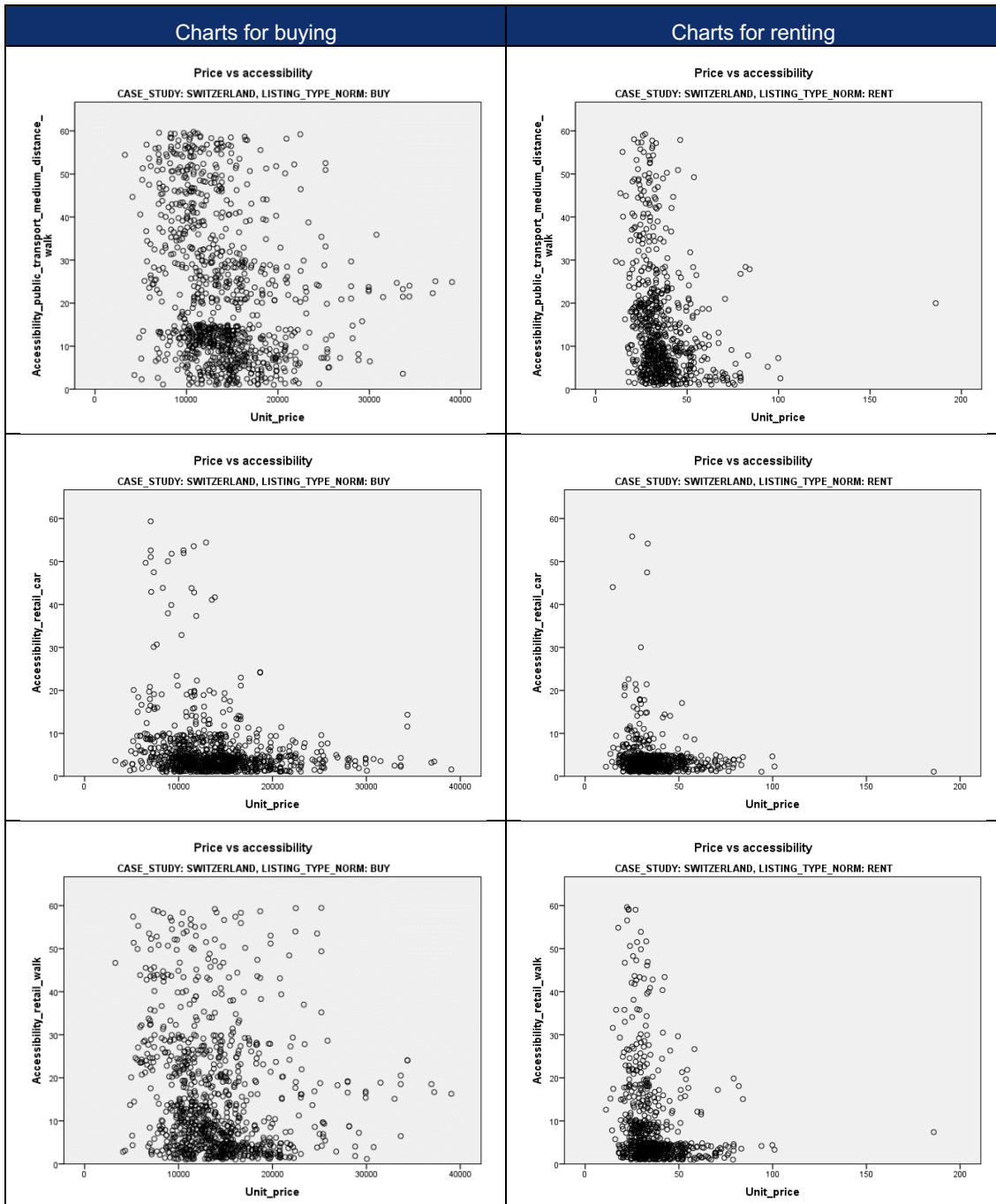
SWITZERLAND, RENT

Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	-,108	-,219	-,149	-,221	-,152	-,267	-,136	-,212
Sig. (2-tailed)	,004	,000	,000	,000	,000	,000	,000	,000
N	725	725	725	725	725	725	725	725

The correlation values for the Swiss municipalities are very low indicating no significant correlation at all. Correlation values are negative indicating that at least the price gets higher when accessibility improves, but not in a very significant way.







2.11 Sweden

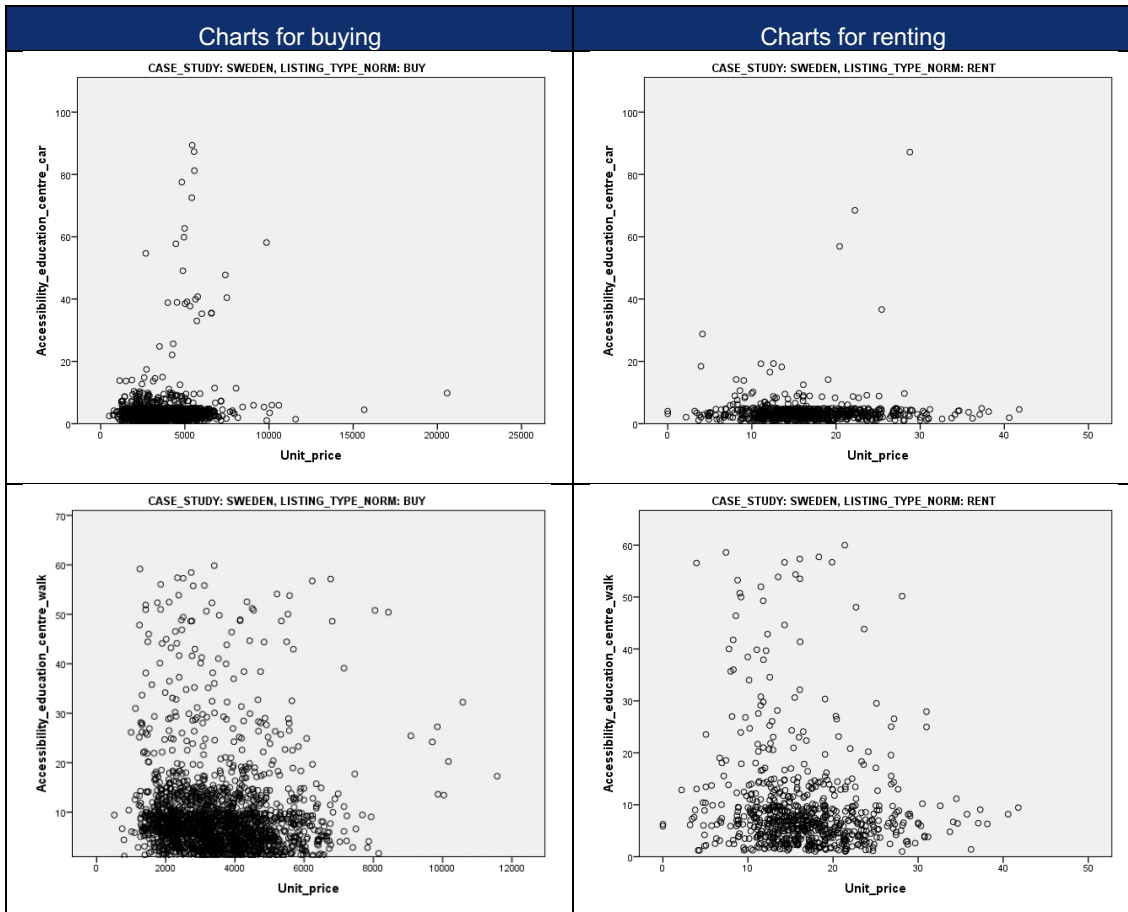
SWEDEN, BUY

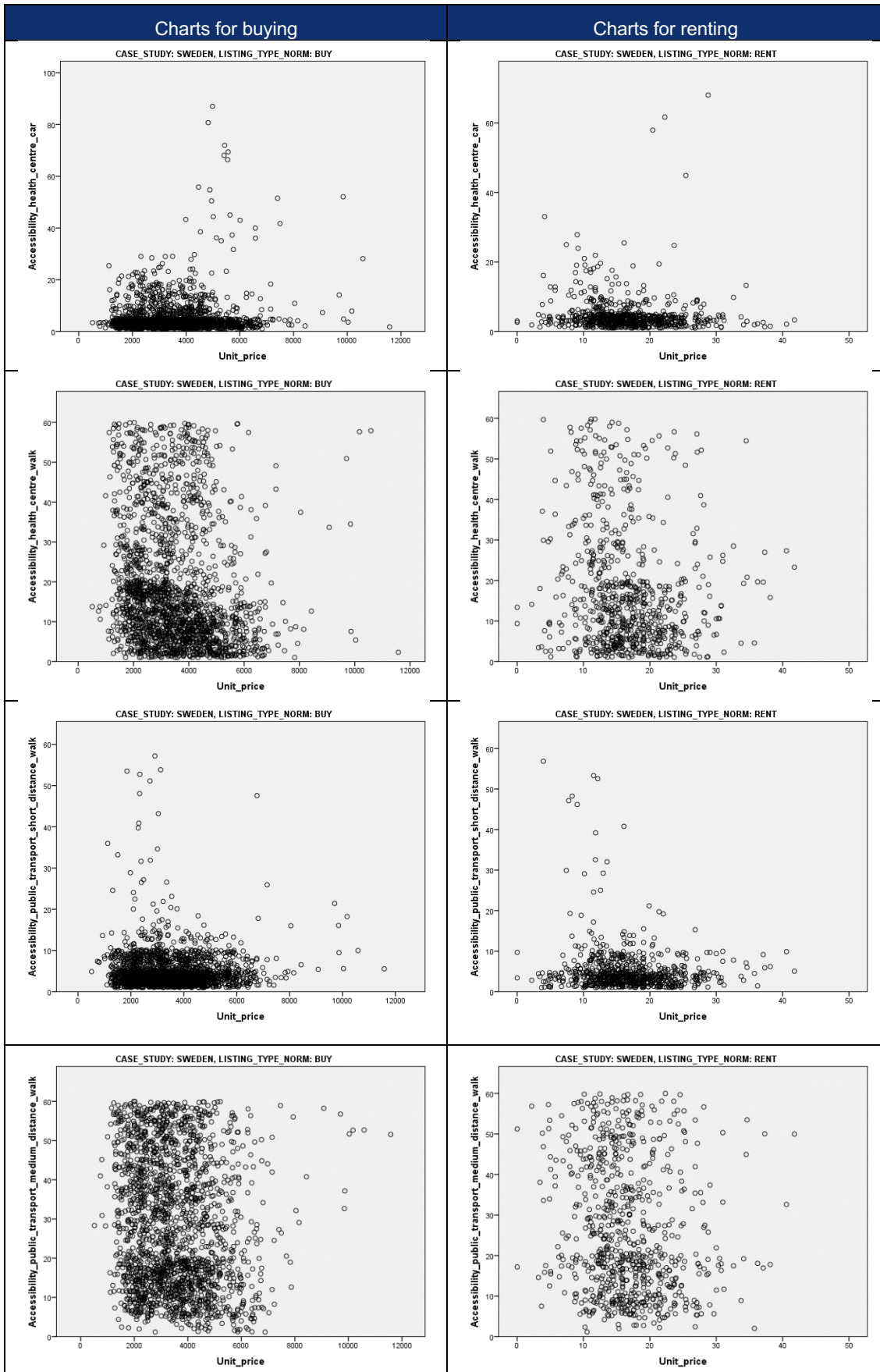
Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	-,045 [*]	-,069	-,040 [*]	-,069	-,079	-,058	-,063	-,078
Sig. (2-tailed)	,020	,000	,039	,000	,000	,003	,001	,000
N	2631	2631	2631	2631	2631	2631	2631	2631

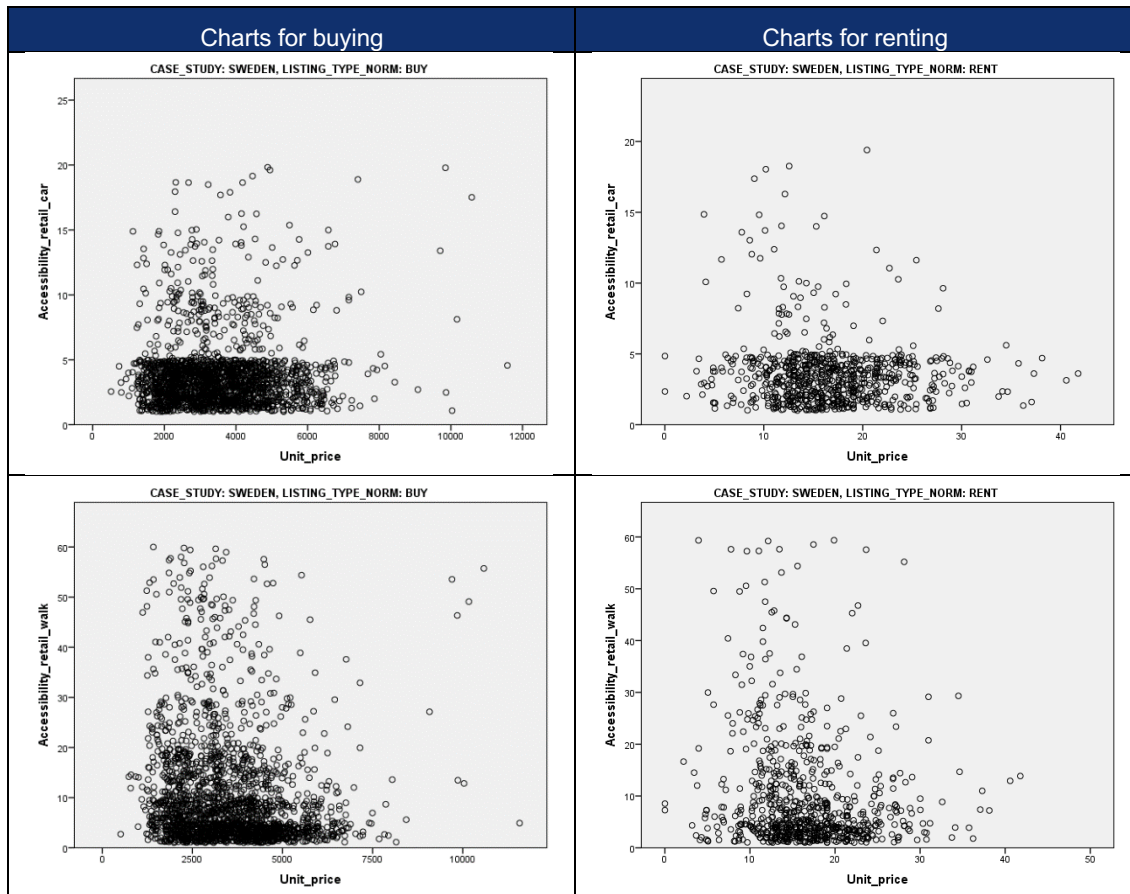
SWEDEN, RENT

Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	-,180	-,188	-,199	-,197	-,206	-,157	-,193	-,183
Sig. (2-tailed)	,000	,000	,000	,000	,000	,000	,000	,000
N	1088	1088	1088	1088	1088	1088	1088	1088

The correlation values for the Swiss municipalities are very low indicating no significant correlation at all. Correlation values are negative indicating that at least the price gets higher when accessibility improves, but not in a very significant way.







2.12 Denmark

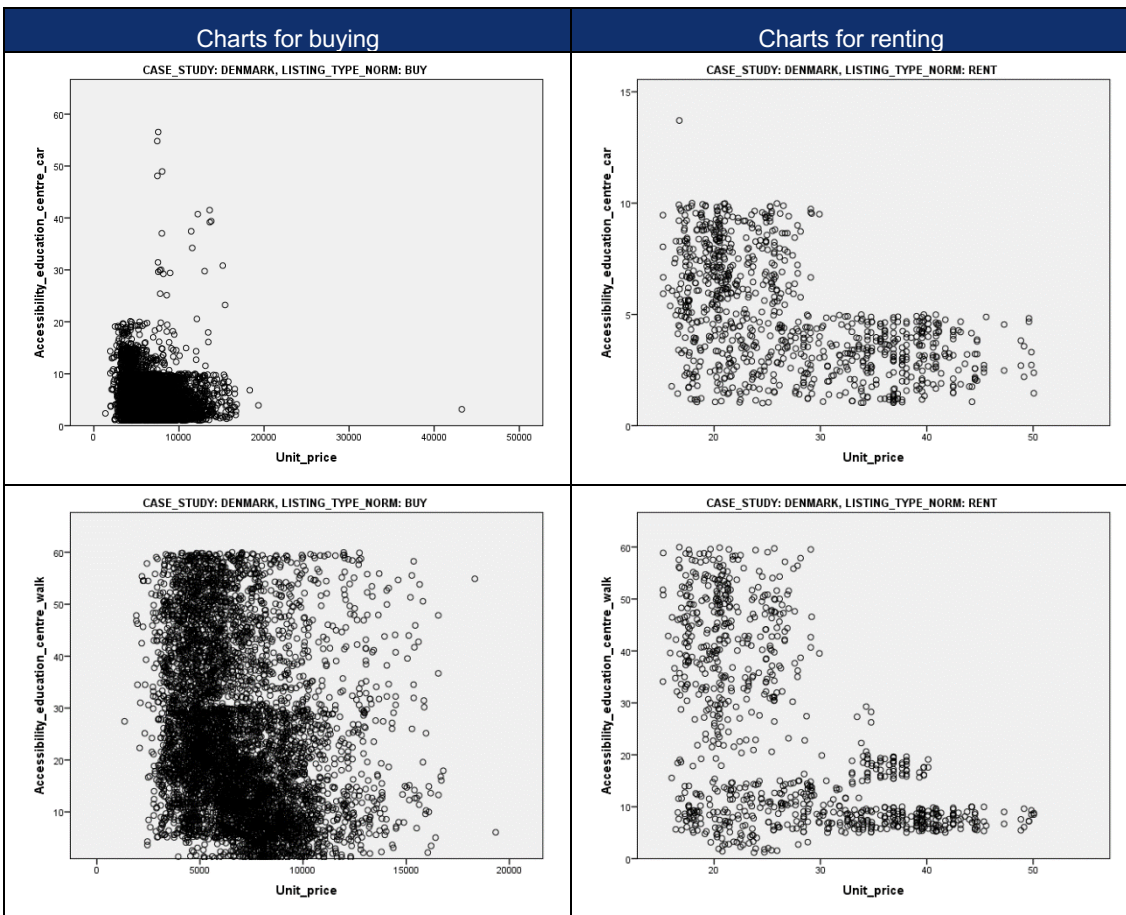
DENMARK, BUY

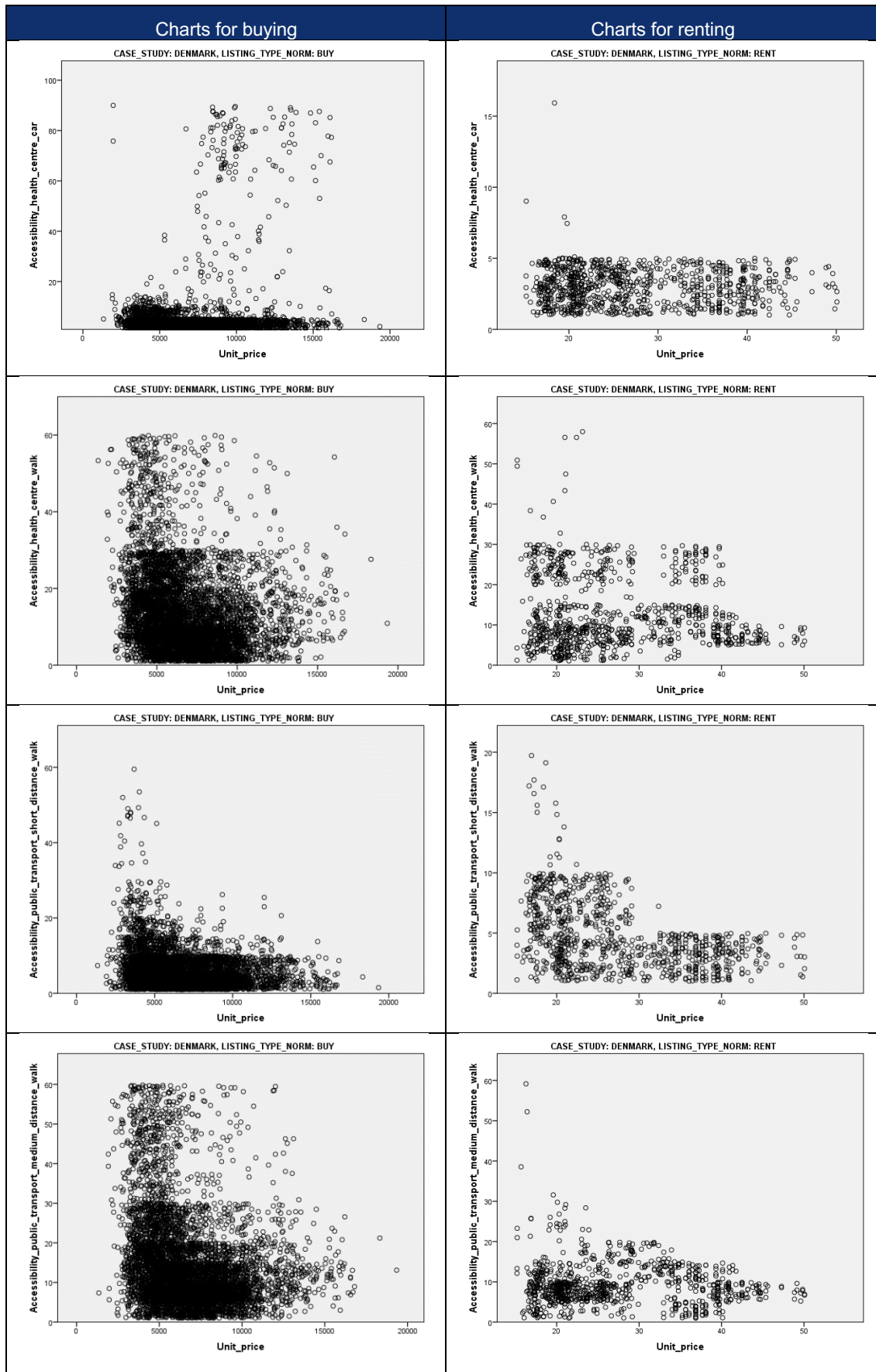
Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	-,188	-,170	-,152	-,189	-,190	-,184	-,156	-,192
Sig. (2-tailed)	,000	,000	,000	,000	,000	,000	,000	,000
N	9756	9756	9756	9756	9756	9756	9756	9756

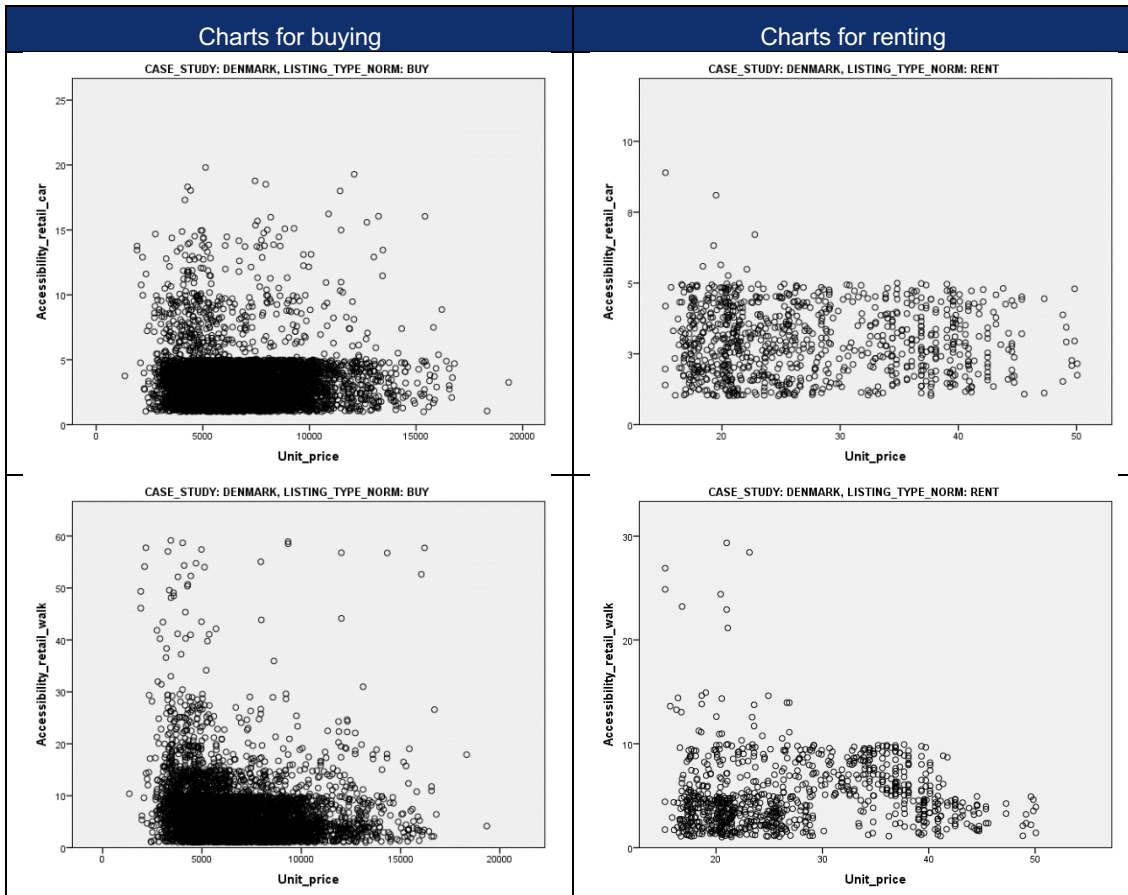
DENMARK, RENT

Unit price	education centre car	education centre walk	health centre car	health centre walk	PT short dist walk	PT mid dist walk	retail car	retail walk
Pearson Correlation	-,300	-,557	-,230	-,286	-,378	-,299	-,239	-,274
Sig. (2-tailed)	,000	,000	,000	,000	,000	,000	,000	,000
N	1025	1025	1025	1025	1025	1025	1025	1025

The correlation values for the Danish municipalities are very low indicating no significant correlation at all. Correlation values are negative indicating that at least the price gets higher when accessibility improves, but not in a very significant way.







3 Accessibility Mapping

Enclosed in this chapter is a copy of every accessibility map produced for the project along with analysis and review of the map per case study. The regression calculations shown in Ch 2 use the data found in these accessibility maps

3.1 Austria-Slovakia

Summary

With regards to the Austria-Slovakia case study, the following maps are exemplary of a well-connected, highly accessible region. Almost all the region is accessible by public transport by bus and all urban areas are within a ten-minute walk of a bus stop or taxi rank. Likewise, the map showing rail illustrates how the urban agglomerations and commuter towns are well serviced by trains. Moreover, we observe the rail corridors connecting the capital cities which allow for the growth of a cross-border functional area as the two regions become further intertwined economically.

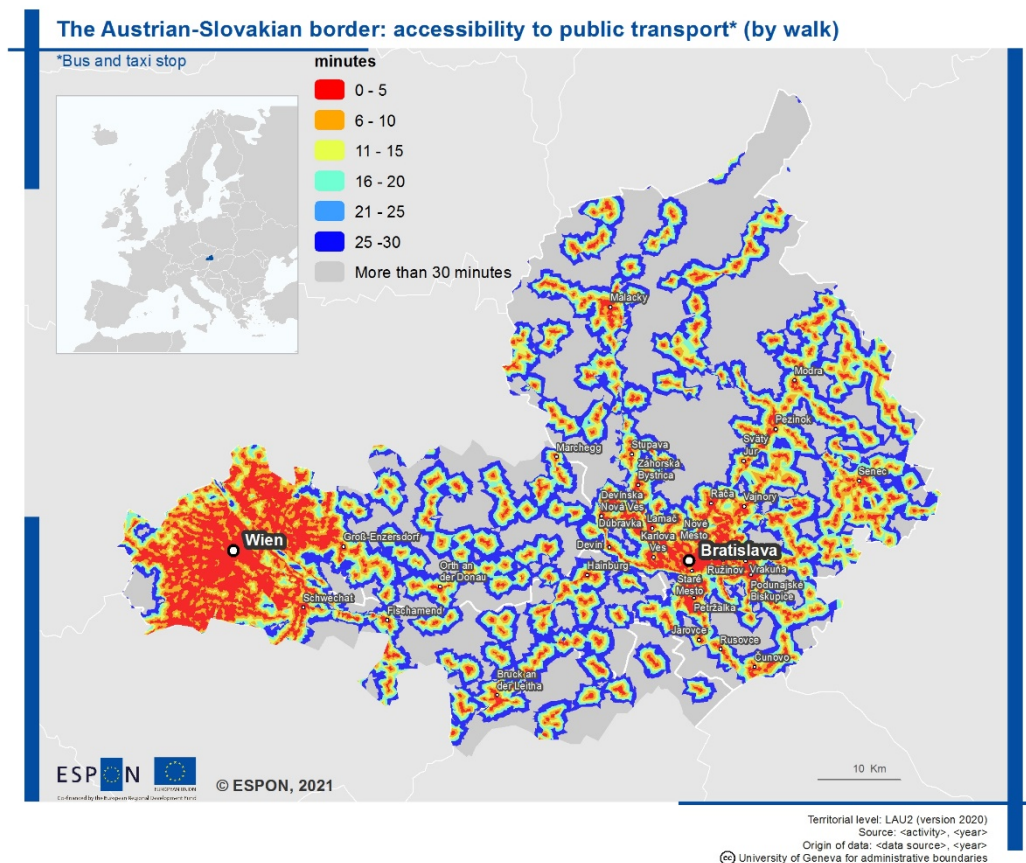


Figure 1: Accessibility Map of Public Transport

Data

This map shows the accessibility to public transport bus and taxi stops, measured as the required walking time from any point in the analysed area to the nearest stop. Results are delivered as isochrones with a 5 minute interval.

Trends and patterns

In terms of accessibility to public transport by walking, the spatial patterns observed are not surprising. Within the major agglomerations and along the main routes, accessibility is overall very good. In comparison with

Figure 2, and accessibility to rail infrastructure, a key public transport means in the corridor region is by bus and taxi.

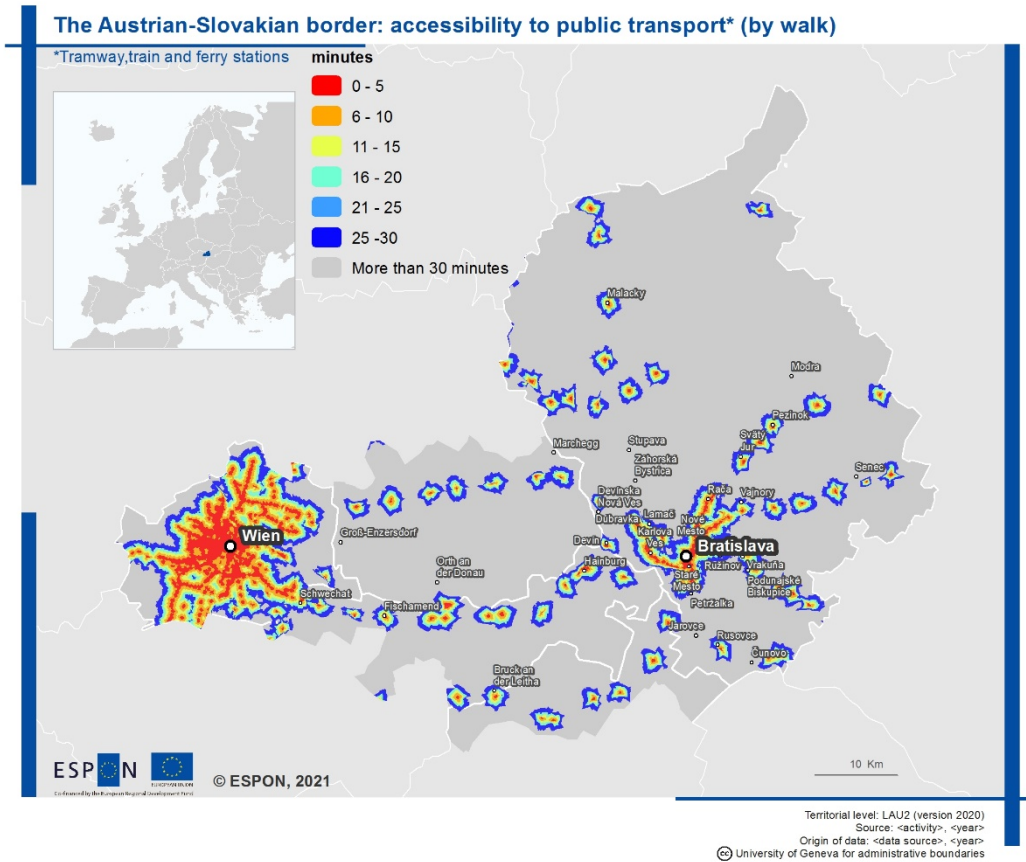


Figure 2: Accessibility Map of Public Transport (Rail)

Data

This map shows the accessibility to public transport tramway, train and ferry stations, measured as the required walking time from any point in the analysed area to the nearest station. Results are delivered as isochrones with a 5 minute interval.

Trends and patterns

Regional accessibility via rail and pedestrian access to a train or tram station is much reduced in comparison to bus stations, but the major transport routes are still visible.

It would be interesting to analyse whether house prices in reach of these major trainline routes are higher which in general is possible with the web scrapping data. However, in the corridor between Bratislava and Vienna for the two months of web scrapping the absence of advertisements makes such an analysis difficult.

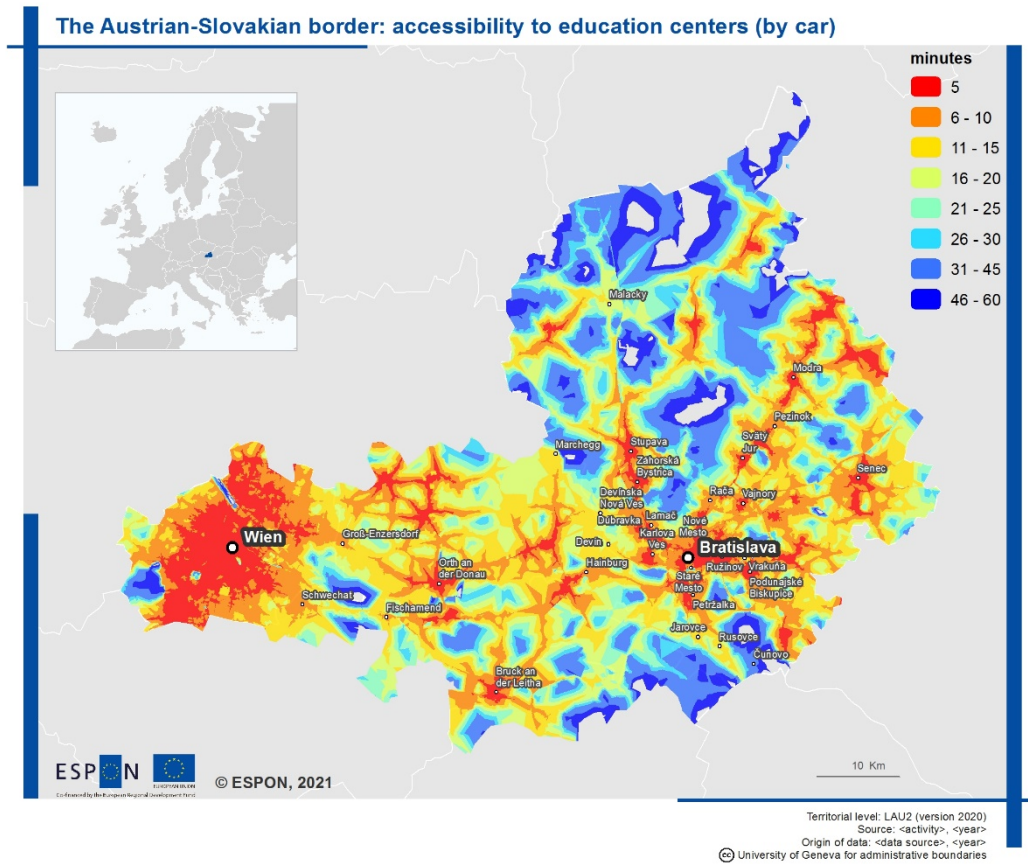


Figure 3: Accessibility to Education Centres

Data

This map shows the accessibility to education centres, measured as the required driving time by car from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Most of the case study region is showing very good accessibility to education centres by car with only a few areas requiring longer than the 45-minute threshold. Yet, on the Slovakian side there are specifically areas in the north with less access to education centres, and these areas are also areas with less profitability and lower price ranges.

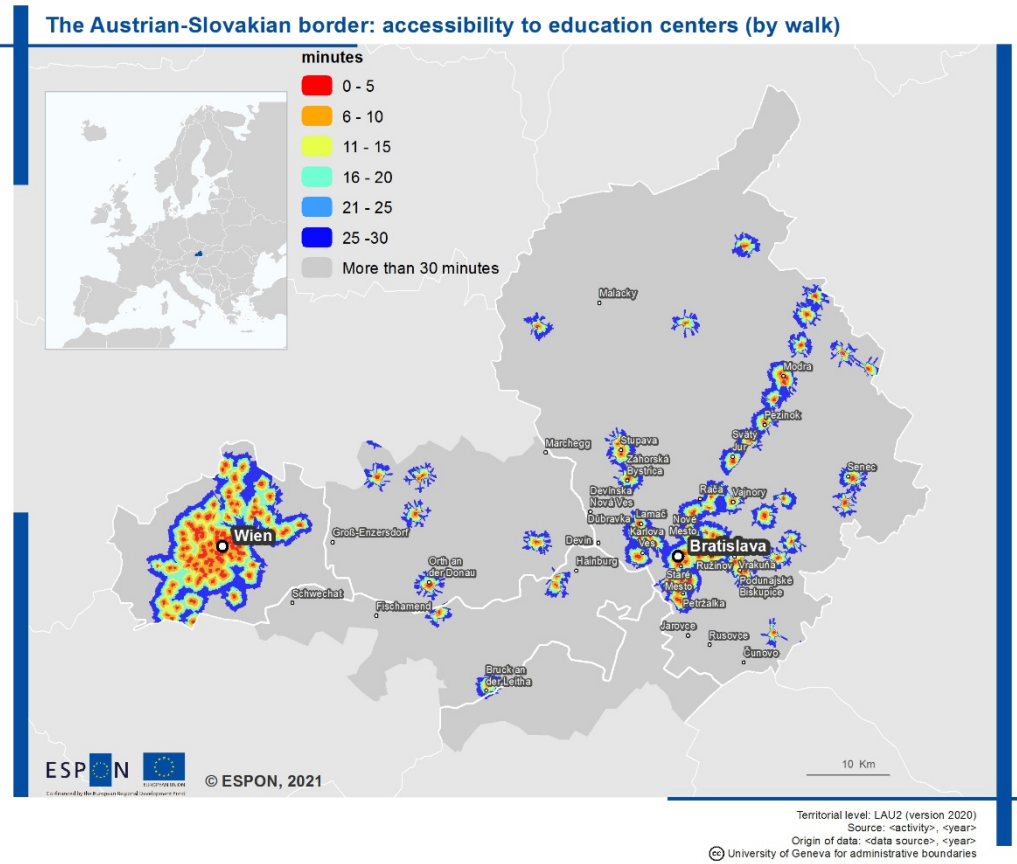


Figure 4: Accessibility to Education Centres by Foot

Data

This map shows the accessibility to education centres, measured as the required walking time from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

The accessibility by foot roughly suggests that apart from in some local smaller agglomerations in the corridor and a route to the east of Bratislava, accessibility to education centres by foot is best in the two major cities highlighting the car dependency of the rural areas. In the border region, the accessibility is rather low on the Austrian side and thus not even visible in the map.

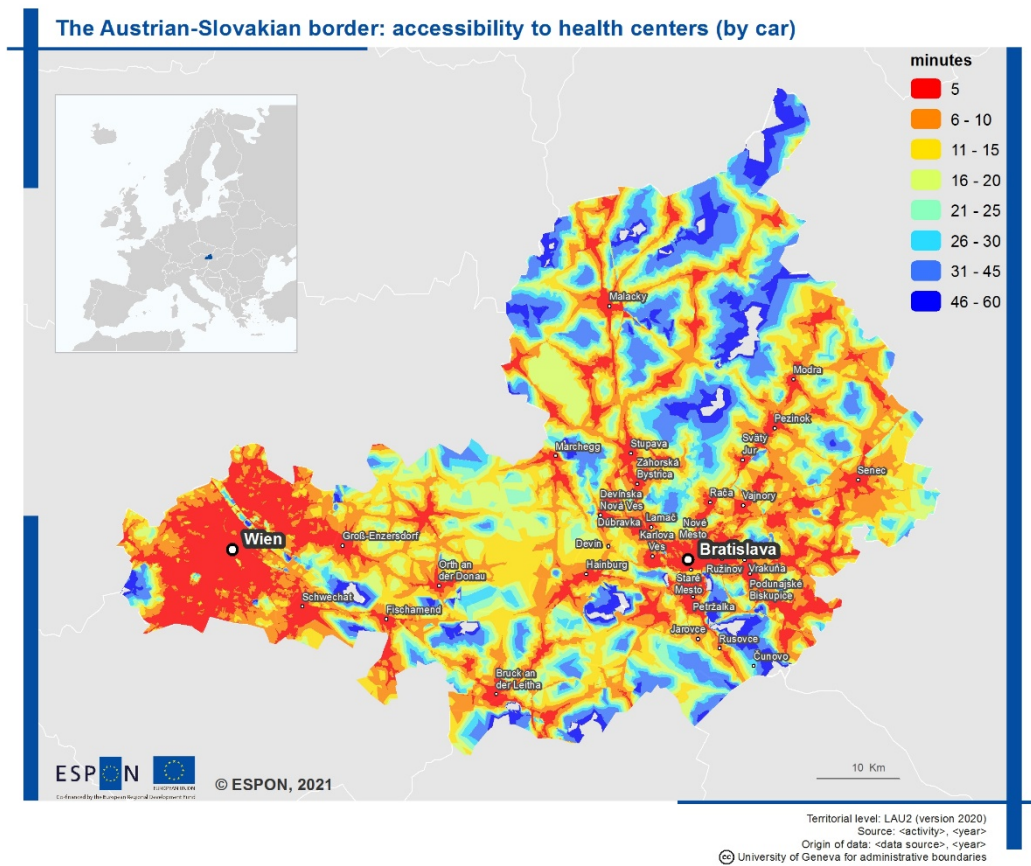


Figure 5: Accessibility to Health Centres

Data

This map shows the accessibility to health centres, measured as the required driving time by car from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Most of the case study region shows average accessibility to health centres by car. The less populated, more rural areas are more poorly served by health centres whereas the urban agglomerations and commuting towns have significantly better access to health centres.

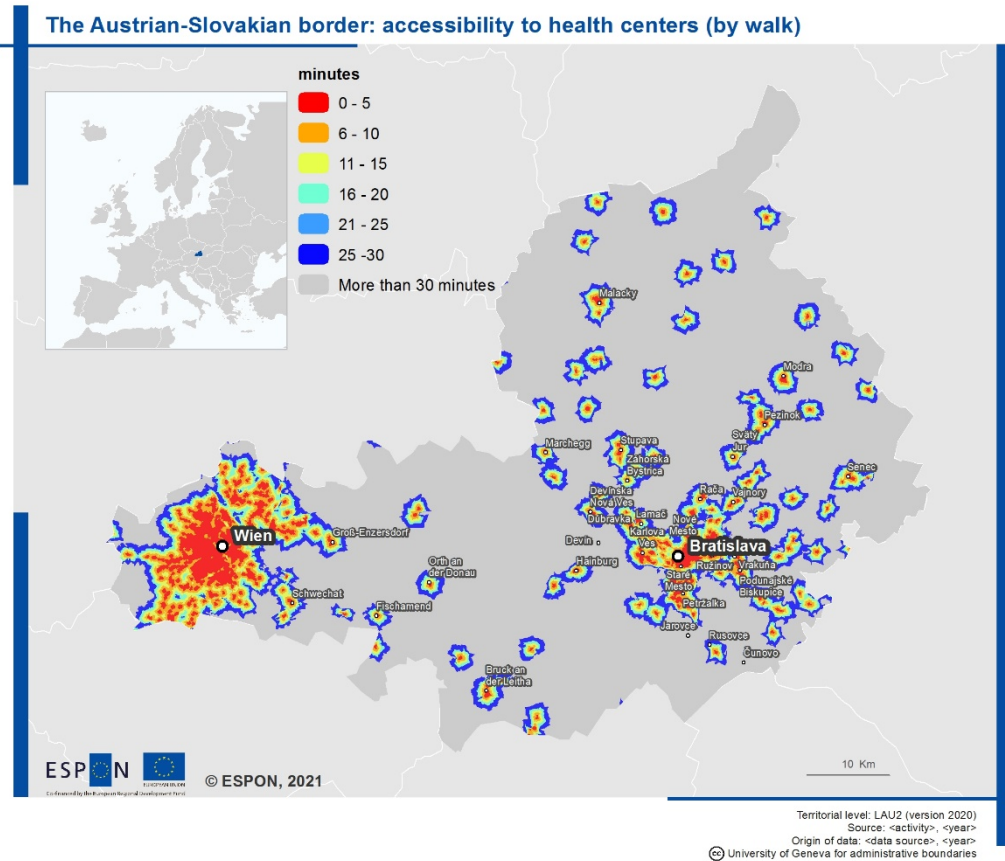


Figure 6: Accessibility to Health Centres by Foot

Data

This map shows the accessibility to health centres, measured as the required walking time from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

The accessibility by foot suggests that most of the region cannot reach a health centre by walking highlighting the high level of car dependency for much of the region except within the urban areas.

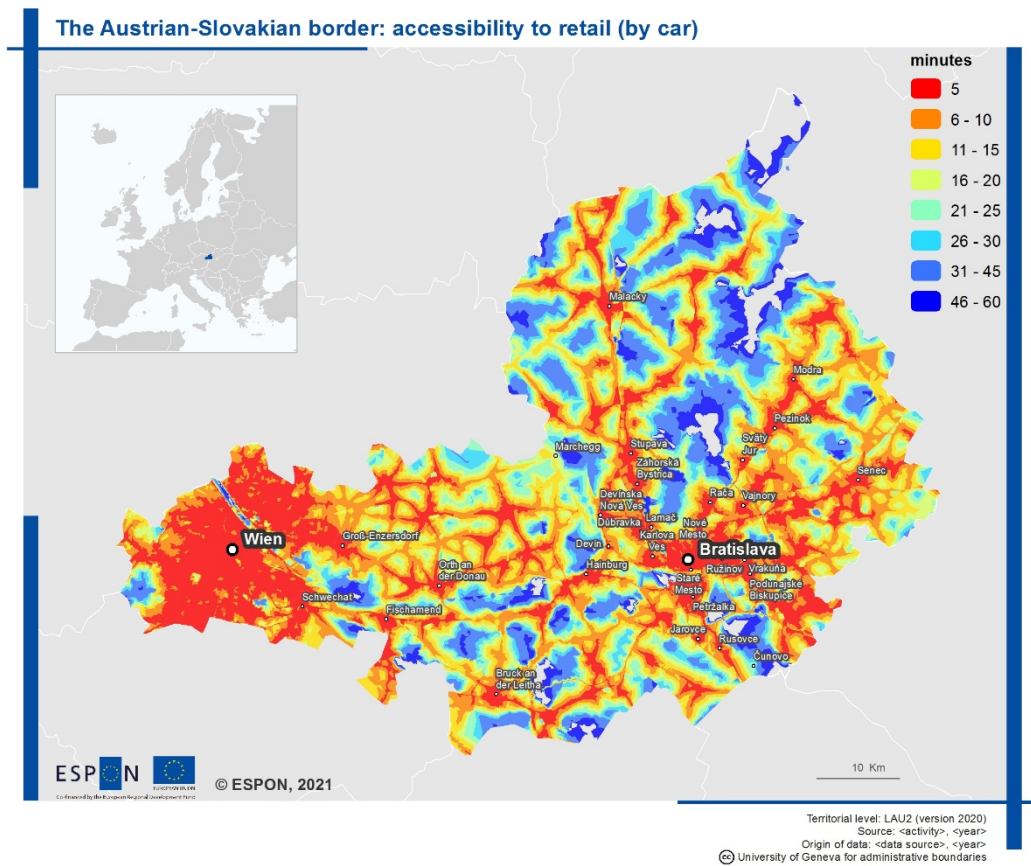


Figure 7: Accessibility to Commercial Centres

Data

This map shows the accessibility to retail shops, measured as the required driving time by car from any point in the analysed area to the nearest shop. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Most of the case study region shows good accessibility to commercial centres by car. Some of the rural areas have longer travel times to reach a commercial centre as the retail viability is weaker in these less populated areas.

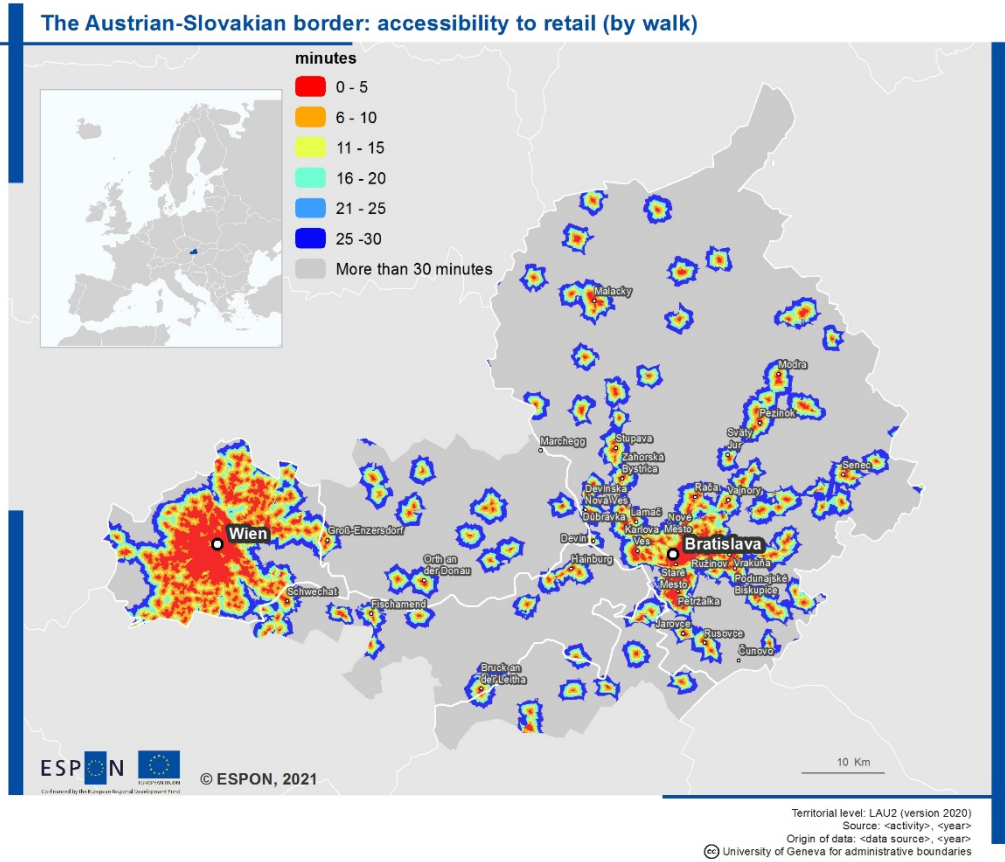


Figure 8: Accessibility to retail (by walk)

Data

This map shows the accessibility to retail shops, measured as the required walking time from any point in the analysed area to the nearest shop. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

The accessibility by foot suggests that most of the region cannot reach a commercial centre by walking highlighting the car dependency for much of the region.

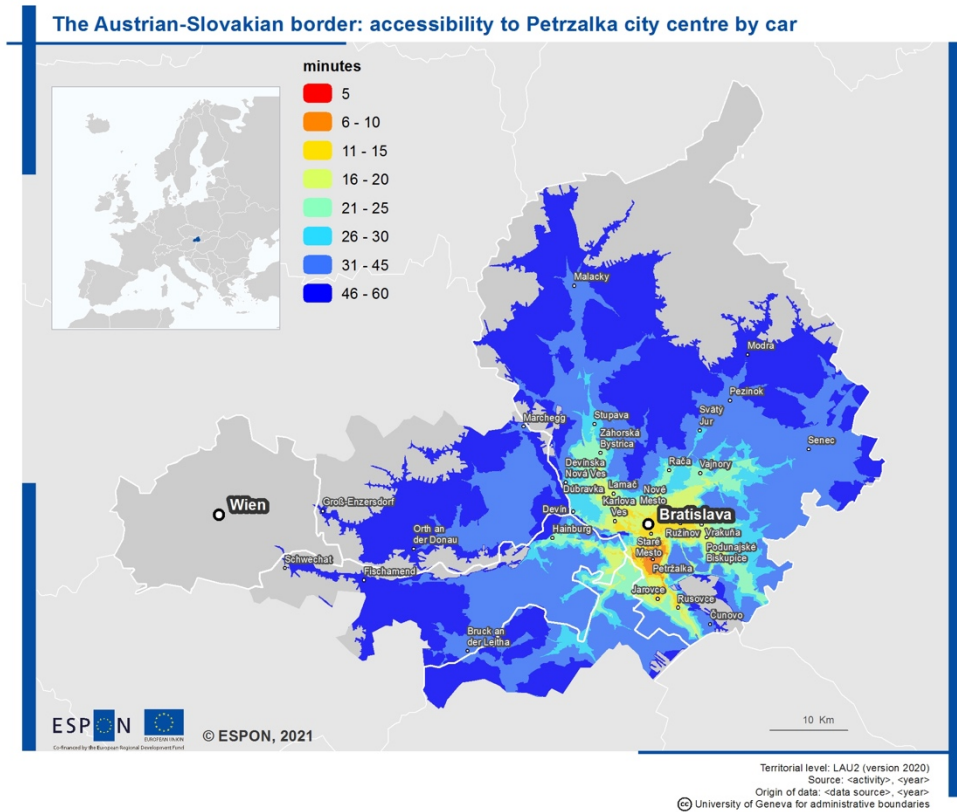


Figure 9: Accessibility to Employment Centres – Slovakian side

Data

This map shows the accessibility to accessibility to employment (using city centres as a proxy), measured as the required driving time by car from any point in the analysed area to the city centre in Petržalka. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

What we can observe from this map is how most of the Austrian border communities are within close proximity to central Bratislava with less than a 30-minute drive to Bratislava for key border communes such as Hainburg an der Donau, Wolsthal and Kittsee. In fact, most of the Austrian border is within an hour's commute drive to Bratislava which exemplifies how accessible this region can be for potential Slovak commuters.

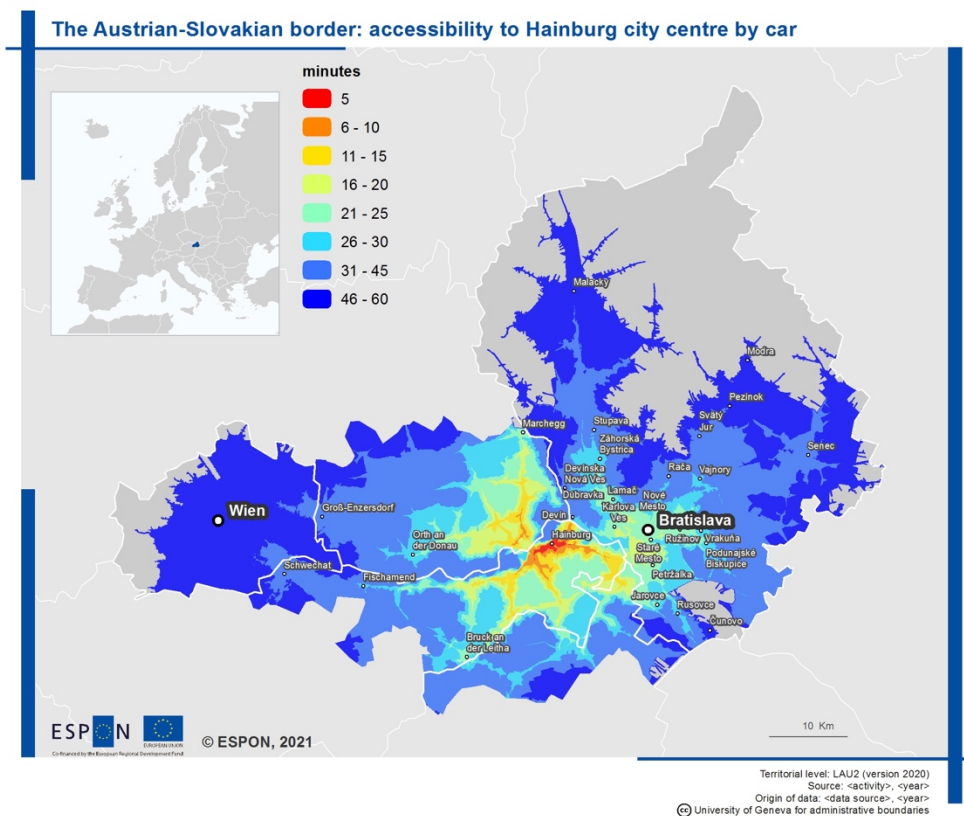


Figure 10: Accessibility to Employment Centres – Austrian side

Data

This map shows the accessibility to accessibility to employment (using city centres as a proxy), measured as the required driving time by car from any point in the analysed area to the city centre in Hainburg. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

On the reverse, access to important Austrian work centres such as Hainburg or Vienna is less accessible from Slovakia. Hence, there is less of an incentive for Austrian workers to migrate to Bratislava as their commutes would be lengthened by the longer distance it takes to reach Austrian work centres from the Slovak-Austrian border. Overall, central Bratislava is within 30 minutes of Hainburg but its outer communities require over 30 minutes of travel to access Hainburg.

3.2 Denmark-Sweden

Summary

Despite being separated by a body of water, Copenhagen and Malmö are relatively well connected due to the construction of Oresund Bridge which allows for passenger rail, freight and private car travel between the two cities. As a consequence, we note that the central urban areas within this case study are the mostly highly connected and accessible parts of the region while the more rural environs and some of the Swedish commuter towns are less connected and accessible. Nevertheless, an inhabitant of Malmö has the potential to reach Copenhagen in 30 minutes by train (unless government border controls impedes free travel causing delay).

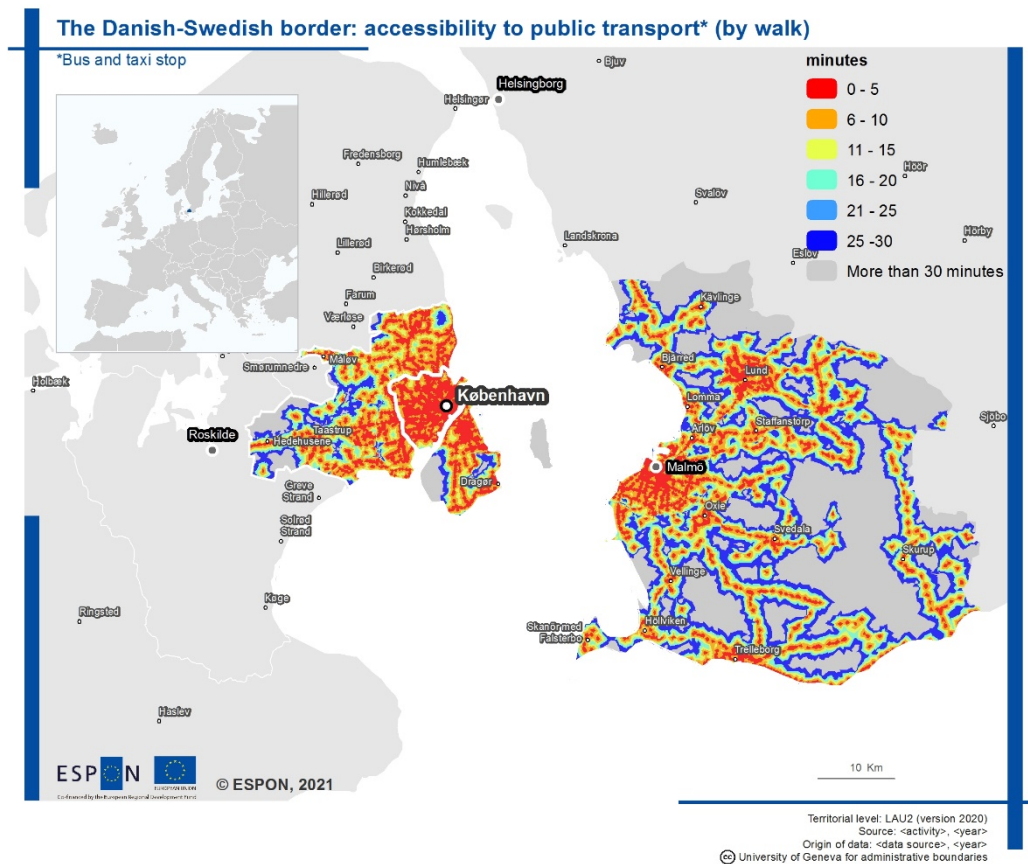


Figure 11: Accessibility to Public Transport

Data

This map shows the accessibility to public transport bus and taxi stops, measured as the required walking time from any point in the analysed area to the nearest stop. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

In terms of accessibility to public transport by walking, the spatial patterns observed illustrate high connectivity to the urban agglomerations of Copenhagen and Malmö and weak connectivity in rural areas. Interestingly, some areas in Skåne County with no public transport connectivity report some high values in rental and purchasing prices.

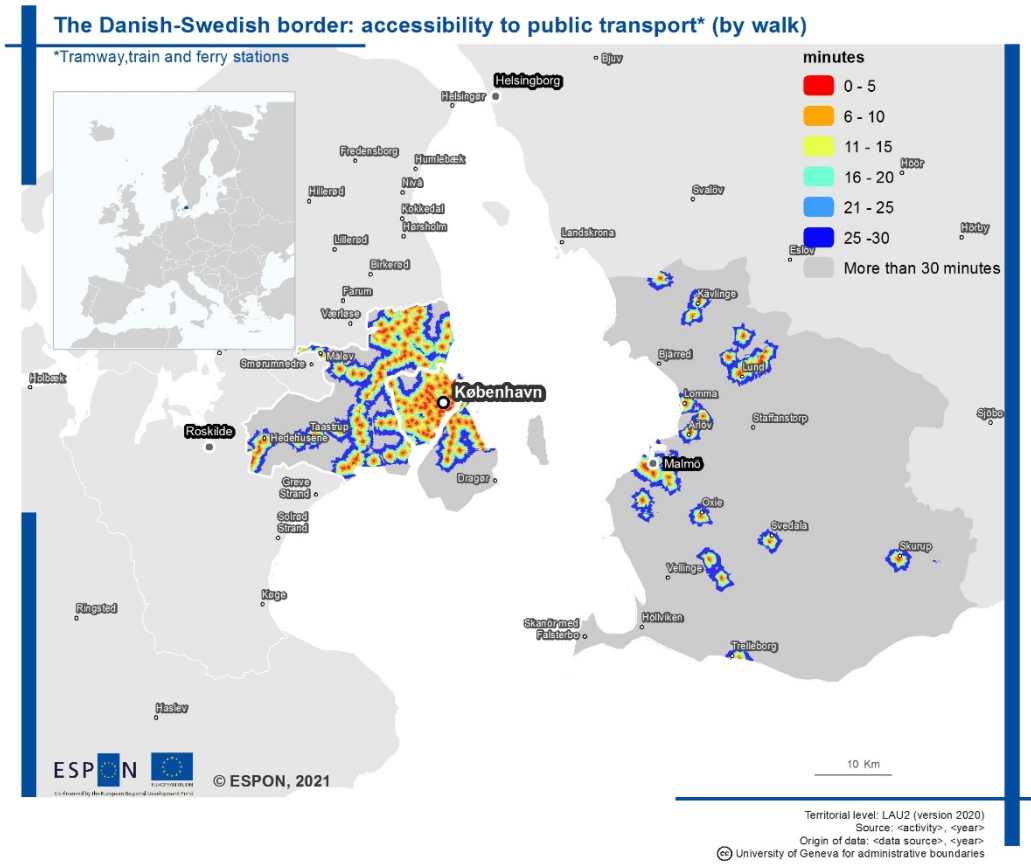


Figure 12: Accessibility to Public Transport (Rail)

Data

This map shows the accessibility to public transport tramway, train and ferry stations, measured as the required walking time from any point in the analysed area to the nearest station. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

As compared to the accessibility map of bus public transport, Sweden is not well serviced by trains or trams. We observe the most urban connectivity in Copenhagen, Malmö and Lund, but outside of these urban areas, the case study region is not well serviced by train or tram transport especially in rural parts of Skåne County.

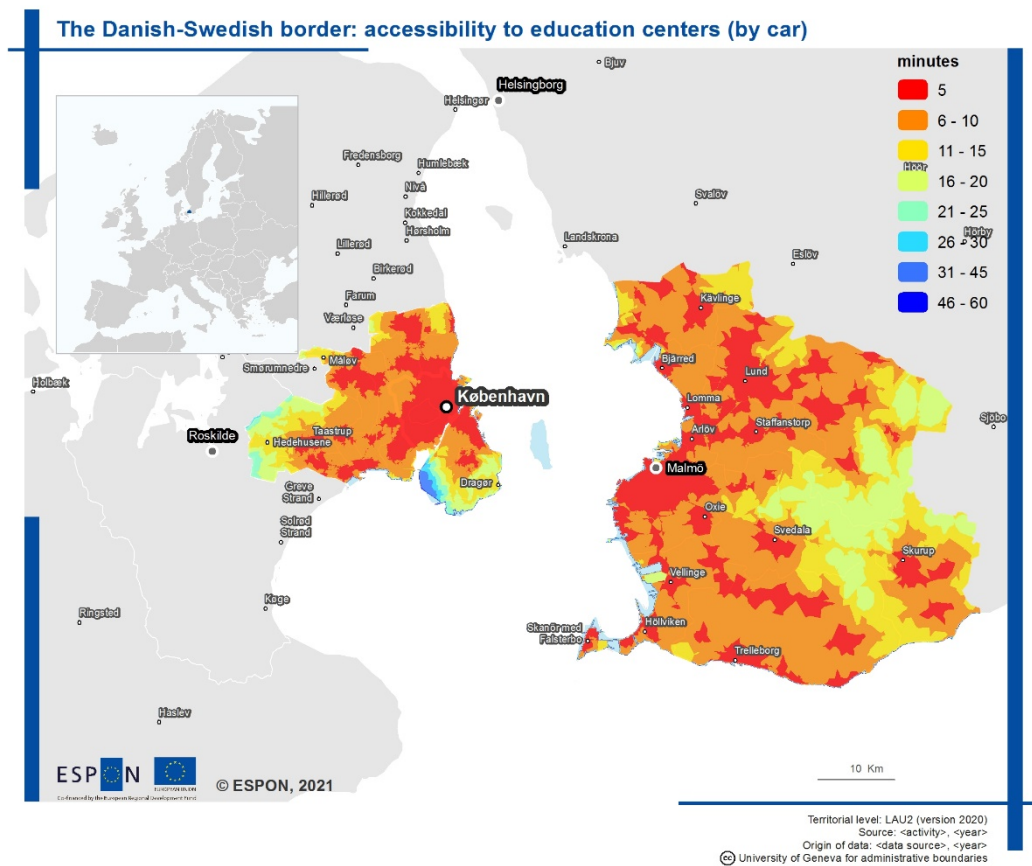


Figure 13: Accessibility to Education Centres

Data

This map shows the accessibility to education centres, measured as the required driving time by car from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Most of the region has excellent accessibility to education centres by car. Very few areas have to travel more than 20 minutes to access an education centre.

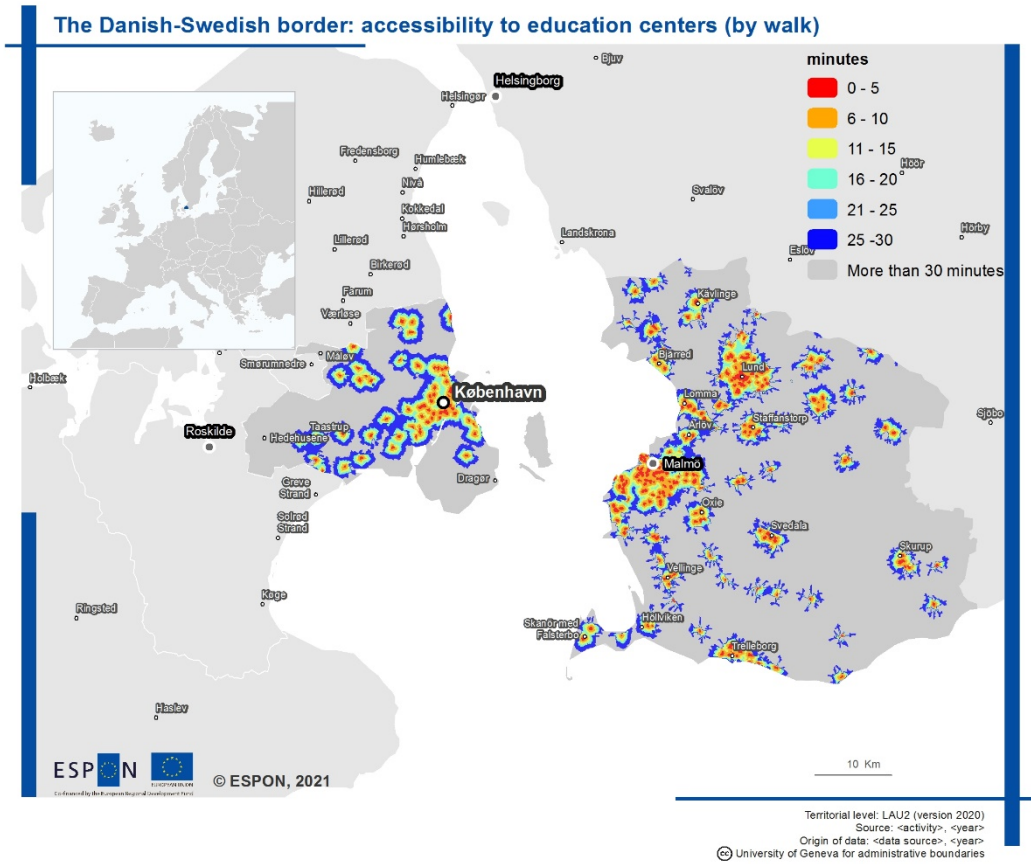


Figure 14: Accessibility to Education Centres by Foot

Data

This map shows the accessibility to education centres, measured as the required walking time from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Much of the region is not serviced by education centres by foot. This illustrates a significant divide between walking and driving where the region is highly connected by road yet has less connectivity for pedestrians.

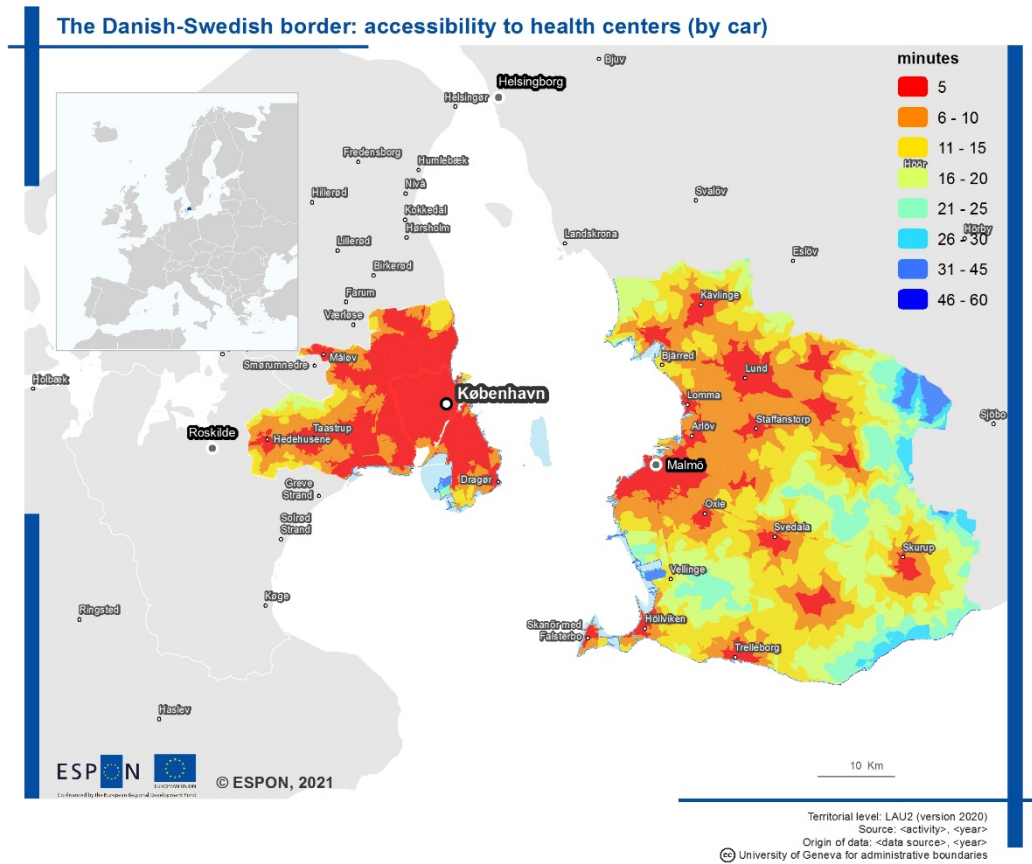


Figure 15: Accessibility to Health Centres

Data

This map shows the accessibility to health centres, measured as the required driving time by car from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

The region has very good accessibility to health centres by car with only a few areas requiring longer than 30 minutes of travel time to access a health centre. Urban areas are especially well covered while more rural areas have longer distances to travel to reach a health service.

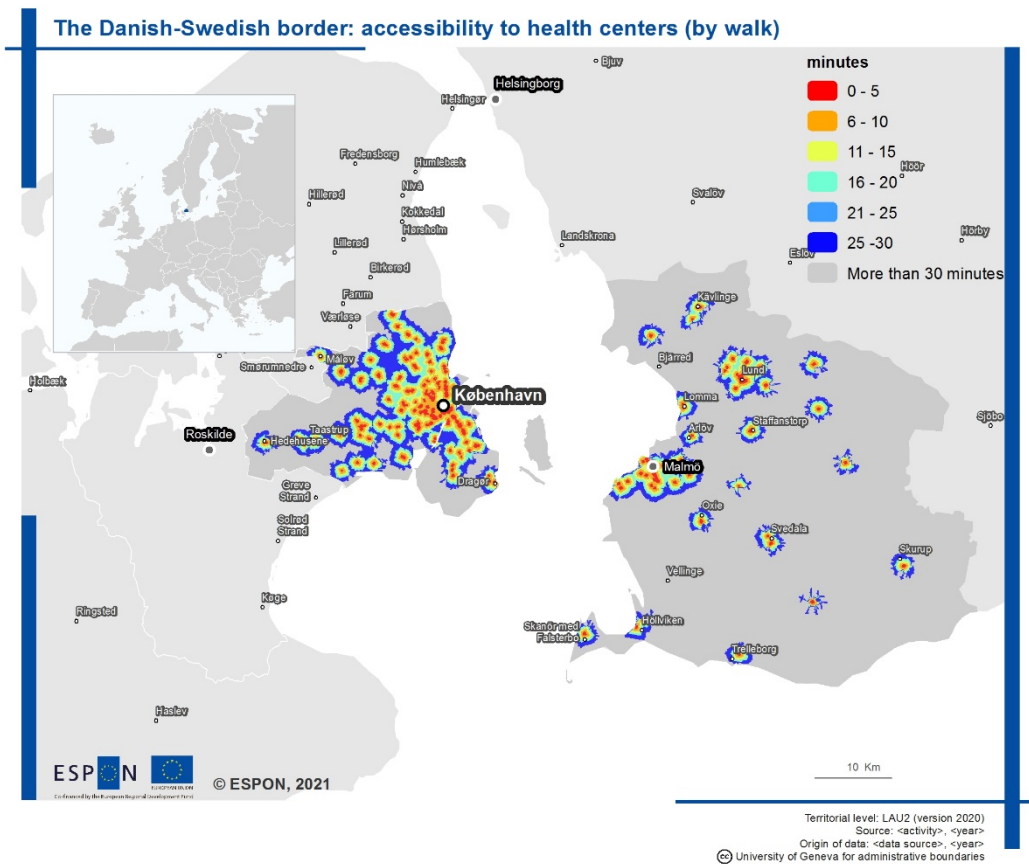


Figure 16: Accessibility to Health Centres by Foot

Data

This map shows the accessibility to health centres, measured as the required walking time from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Again, much of the region is not serviced by health centres by walking illustrating strong car dependency for the region especially in the rural areas of Sweden and suburban parts of Copenhagen.

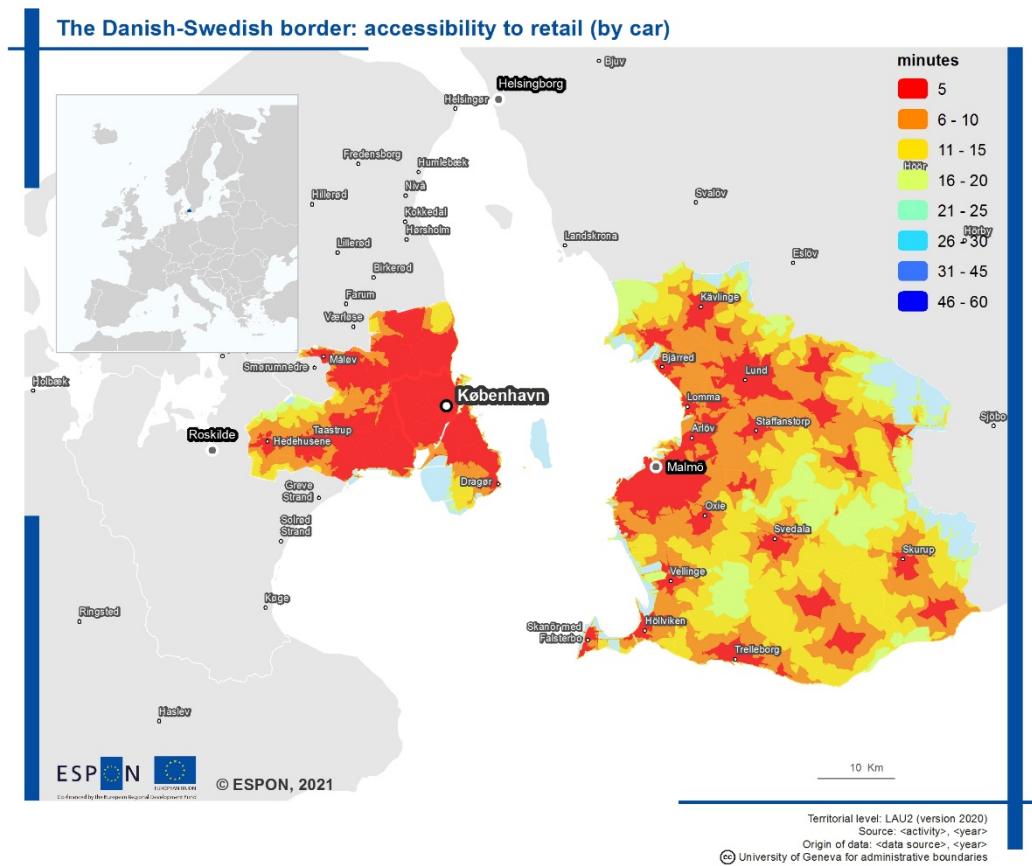


Figure 17: Accessibility to Commercial Centres

Data

This map shows the accessibility to retail shops, measured as the required driving time by car from any point in the analysed area to the nearest shop. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

This region has excellent accessibility to commercial centres by car where all of the region can access commercial centres in less than 30 minutes.

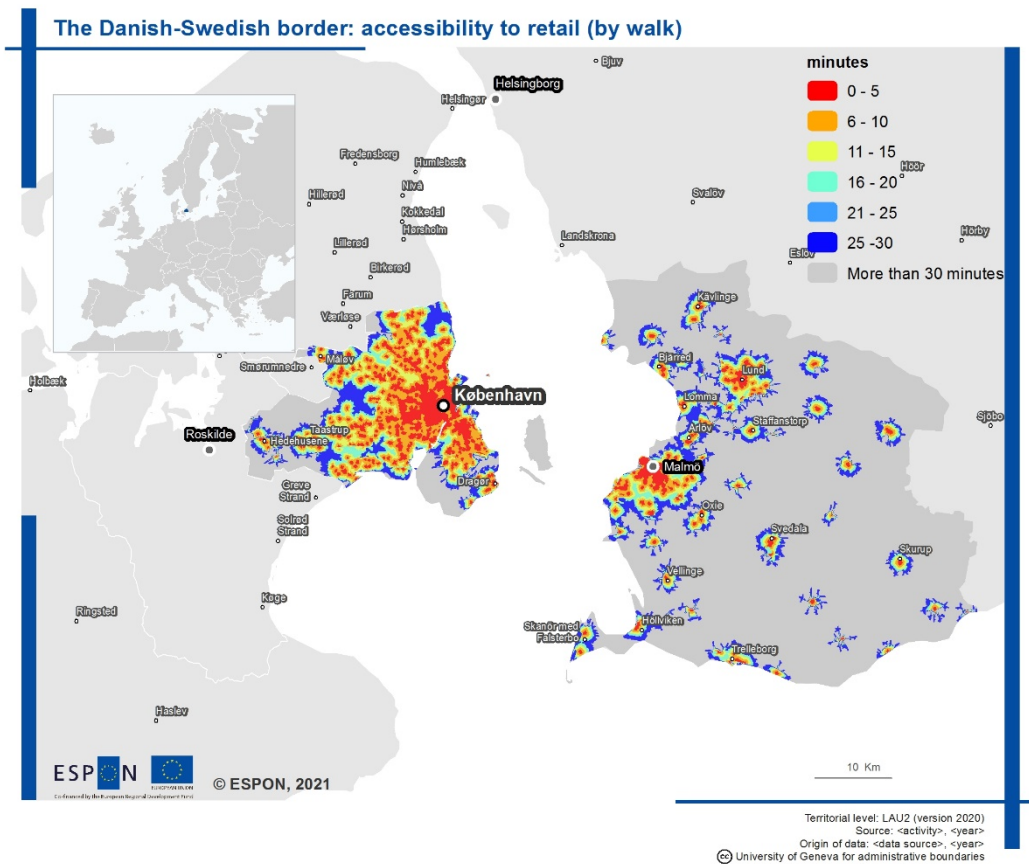


Figure 18: Accessibility to Commercial Centres by Foot

Data

This map shows the accessibility to retail shops, measured as the required walking time from any point in the analysed area to the nearest shop. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

The accessibility by foot suggests that most of the region cannot reach a commercial centre by walking highlighting the car dependency for much of the region.

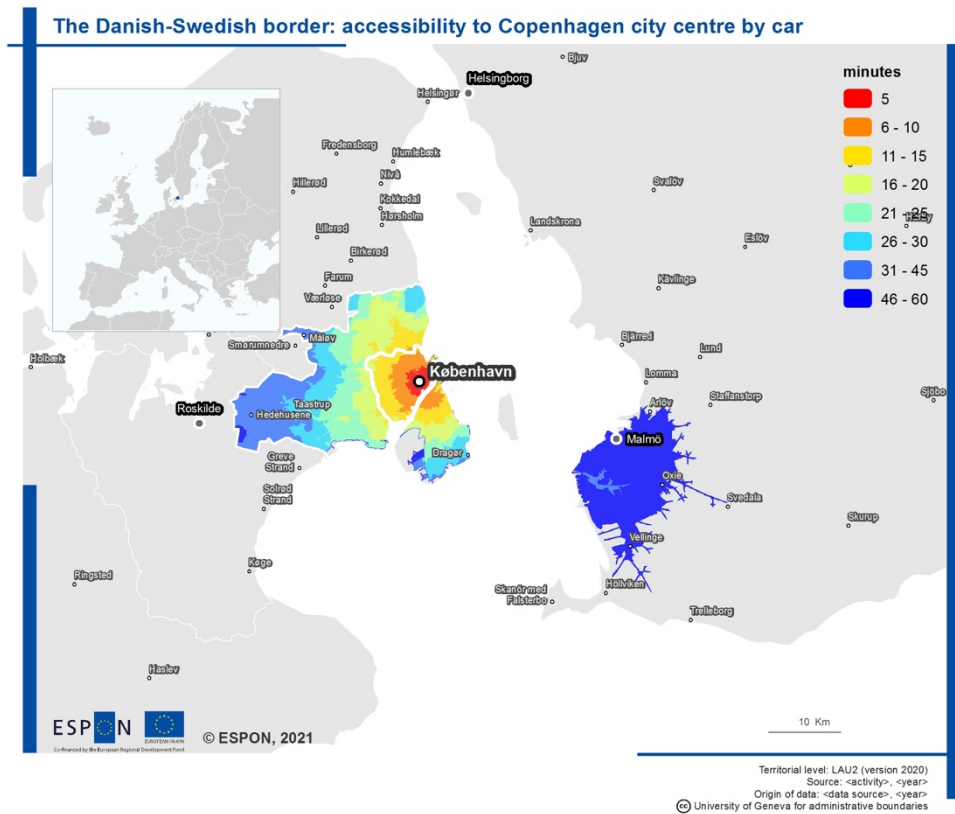


Figure 19: Accessibility to Employment Centres – Danish side

Data

This map shows the accessibility to accessibility to employment (using city centres as a proxy), measured as the required driving time by car from any point in the analysed area to the city centre in Copenhagen. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

What we can observe in this map is that Malmö is not within close proximity to central Copenhagen. This means that households who choose to commute from Malmö to Copenhagen by private vehicle would require over 45 minutes of travel. Hence, public transport options such as train and bus may be a better alternative for cross-border workers commuting to Copenhagen.

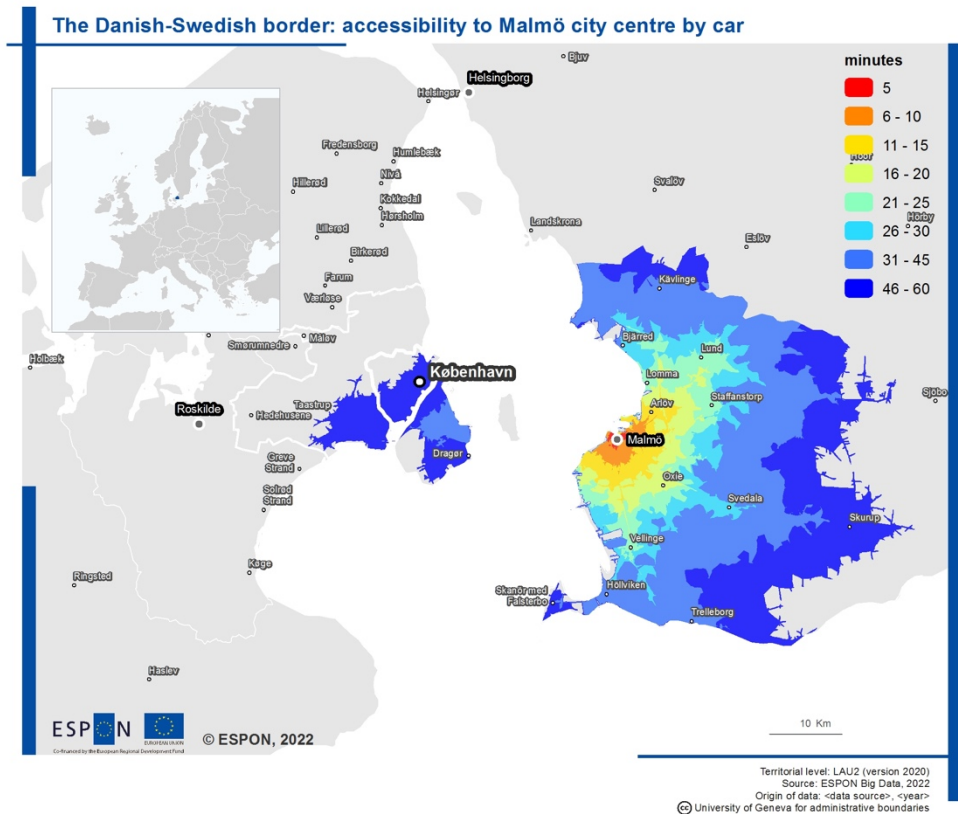


Figure 20: Accessibility to Employment Centres – Swedish side

Data

This map shows the accessibility to accessibility to employment (using city centres as a proxy), measured as the required driving time by car from any point in the analysed area to the city centre in Malmö. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Again, we see a similar pattern play out as in Figure 19 where commuters from Denmark to central Malmö would require car journeys of over 45 mins to reach work. Hence, public transport by regional and commuter train may be a better solution for cross-border travel within this region.

3.3 Ireland-Northern Ireland

Summary

Compared to other border regions of similar scale and importance, the Irish border has relatively poor accessibility and lower levels of integration despite close cultural ties connecting communities across the border. This is particularly true for the region's accessibility via public transport which is poor for both bus and train travel. This indicates that the Irish functional cross-border region is dependent on private cars for day-to-day transport and is exemplary of the region's need to further invest in transport and infrastructure links.

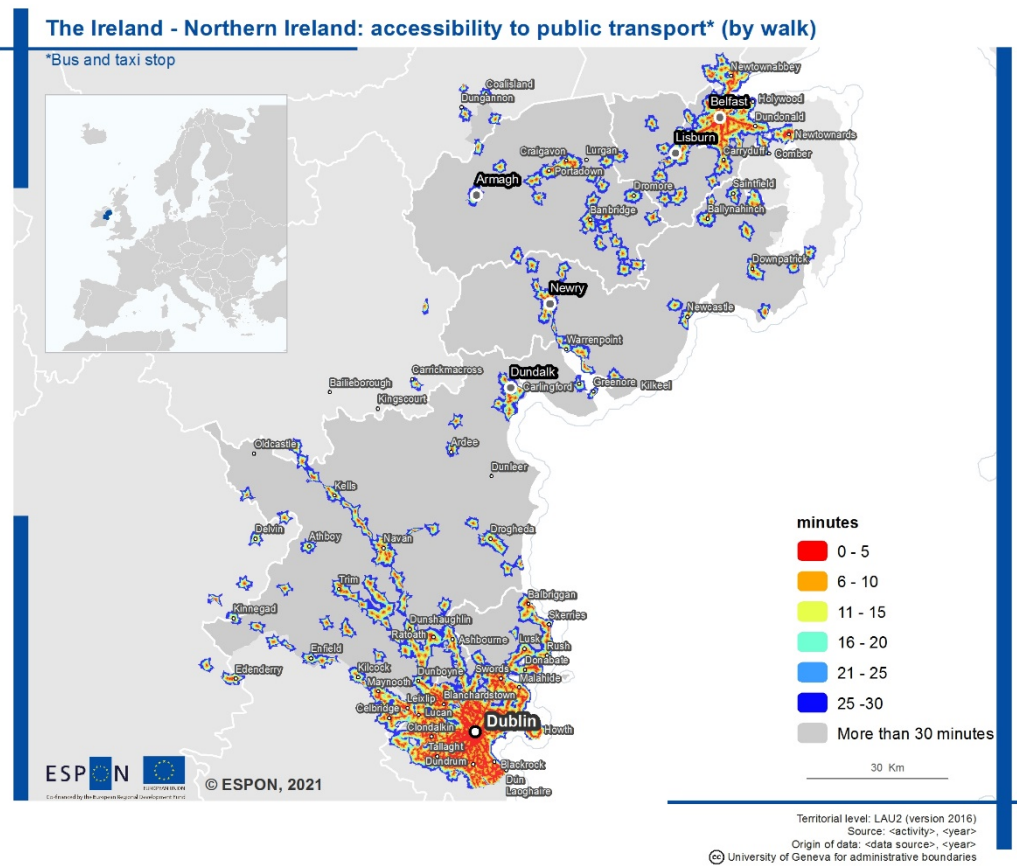


Figure 21: Accessibility of Public Transport

Data

This map shows the accessibility to public transport bus and taxi stops, measured as the required walking time from any point in the analysed area to the nearest stop. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

In terms of accessibility to public transport by walking, the spatial patterns observed illustrate high connectivity to the urban agglomerations of Belfast and Dublin and weak connectivity in rural areas. One surprising finding is the lack of public transport connectivity along the M1/A1 corridor. Given the importance of this roadway for regional accessibility, we would have expected to have observed greater public transport connectivity along this corridor.

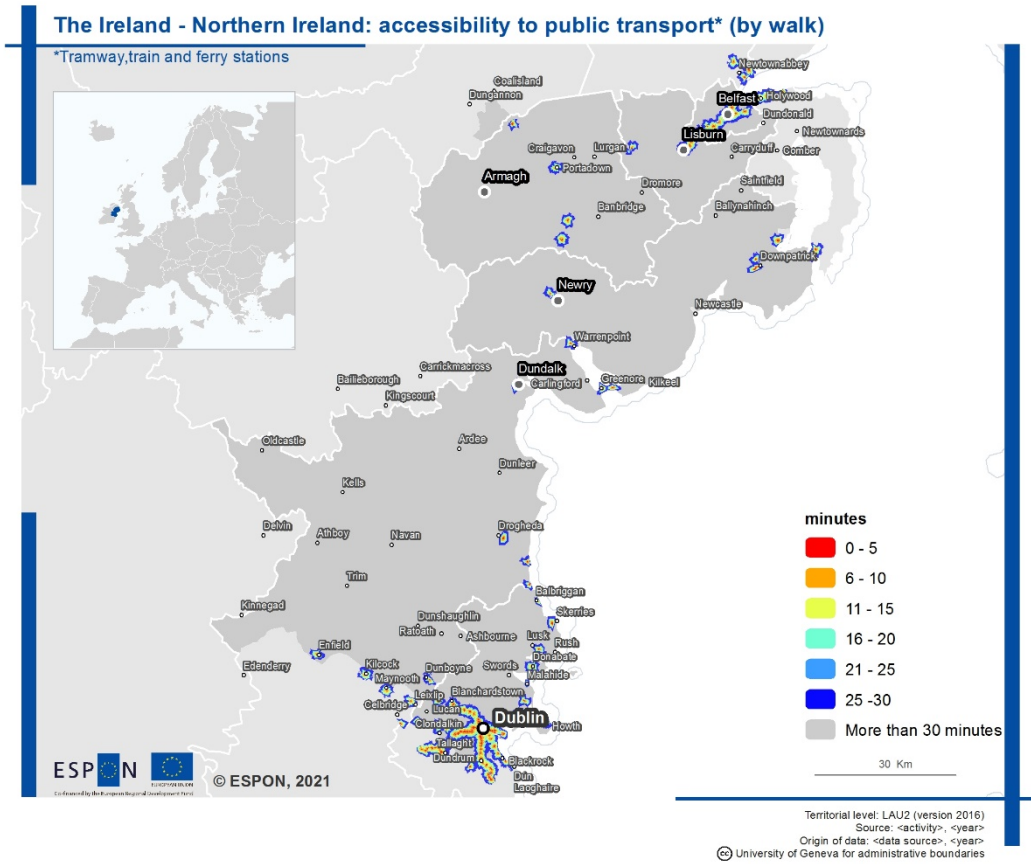


Figure 22: Accessibility of Public Transport (Rail)

Data

This map shows the accessibility to public transport tramway, train and ferry stations, measured as the required walking time from any point in the analysed area to the nearest station. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

As compared to the accessibility map of bus public transport, Ireland is not well serviced by trains or trams. We observe some urban connectivity in both Dublin and Belfast, but overall, very little of the case study region is covered by train or tram transport.

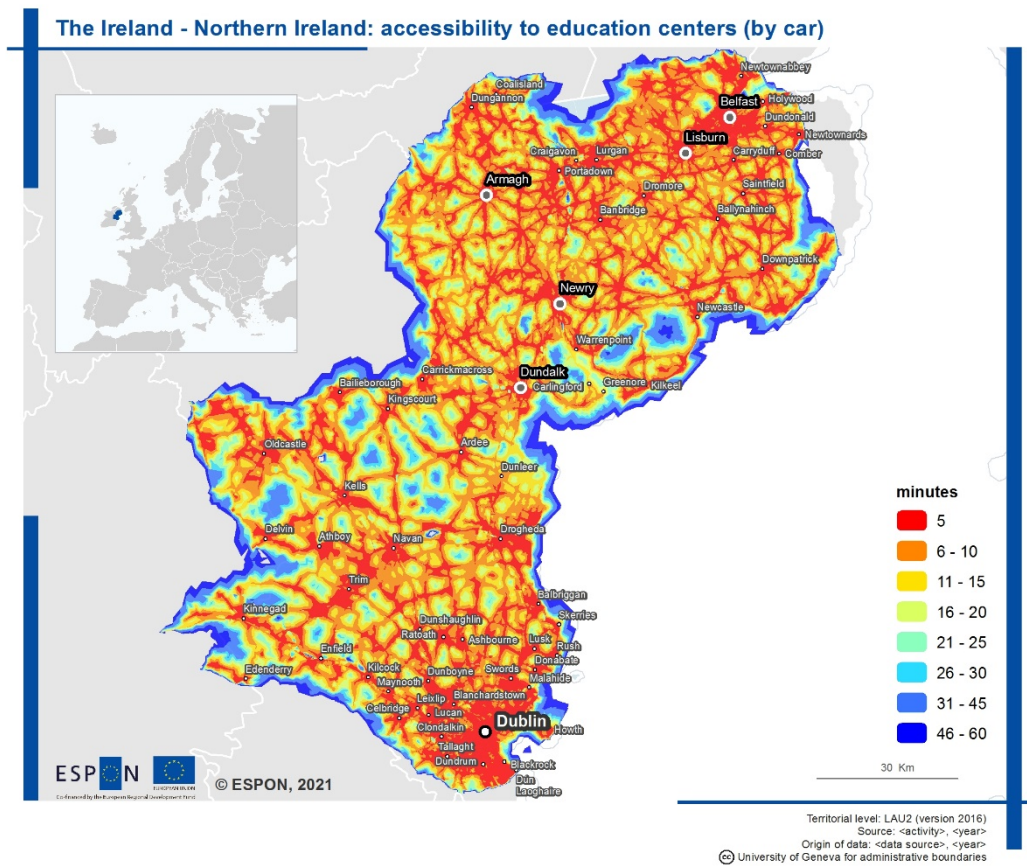


Figure 23: Accessibility to Education Centres

Data

This map shows the accessibility to education centres, measured as the required driving time by car from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Most of the case study region shows very good accessibility to education centres by car. Some of the inland rural areas are less accessible to education centres as their road connectivity and service capacity is poorer than in the urban areas.

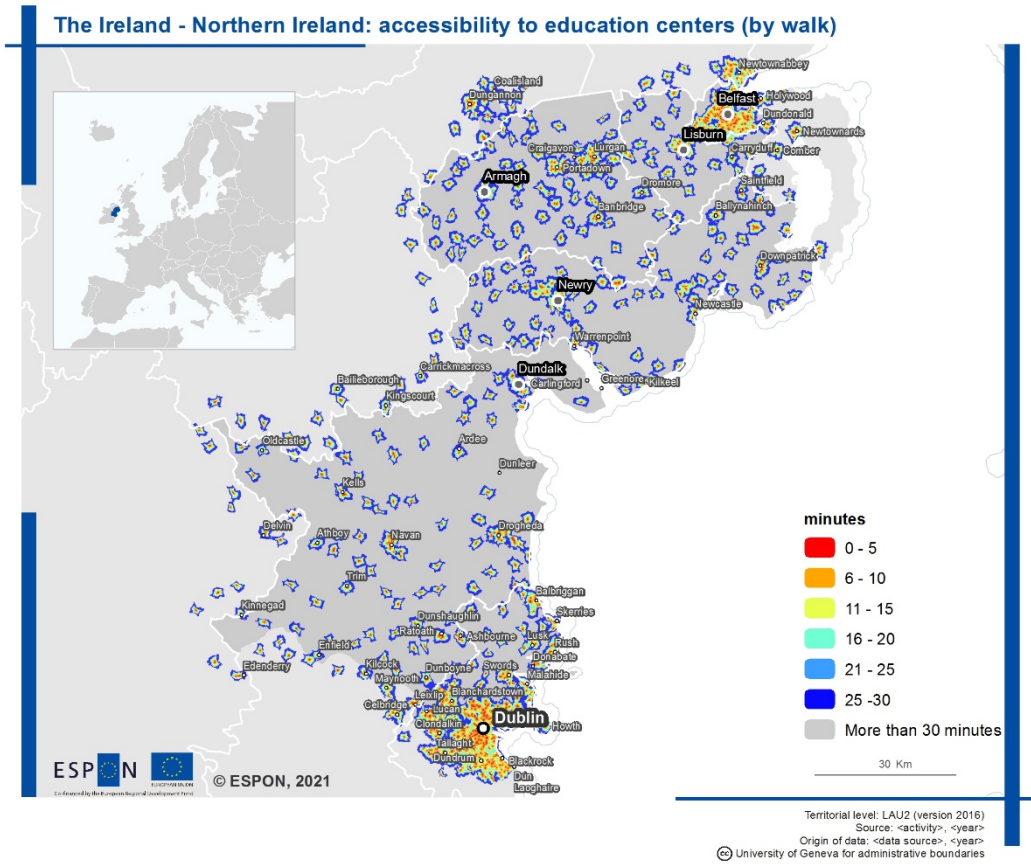


Figure 24: Accessibility to Education Centres by Foot

Data

This map shows the accessibility to education centres, measured as the required walking time from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

The accessibility by foot roughly suggests that apart accessibility to education centres by foot is best in the two major cities whereas many of the rural areas have no access to education centres highlighting the car dependency for much of the region. It may be noted that there are more education centres in the North. This does not necessarily translate to better regional accessibility though as most Northern Irish households send their children to schools of their religious affiliation. Hence, there is a duplicity of schools across the region to serve the different segments of the local population.

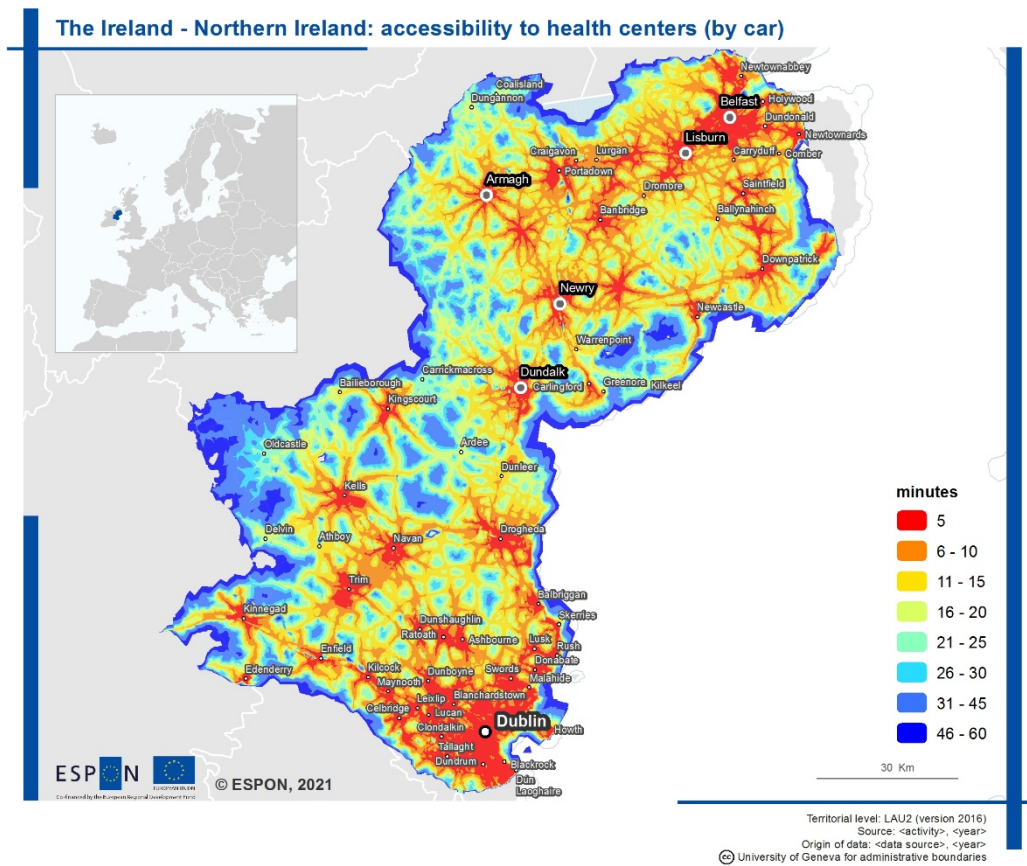


Figure 25: Accessibility to Health Centres

Data

This map shows the accessibility to health centres, measured as the required driving time by car from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Most of the case study region shows good accessibility to health centres by car. The inland rural areas are more poorly served by health centres as most of the health centres are located in the urban agglomerations and large commuting towns.

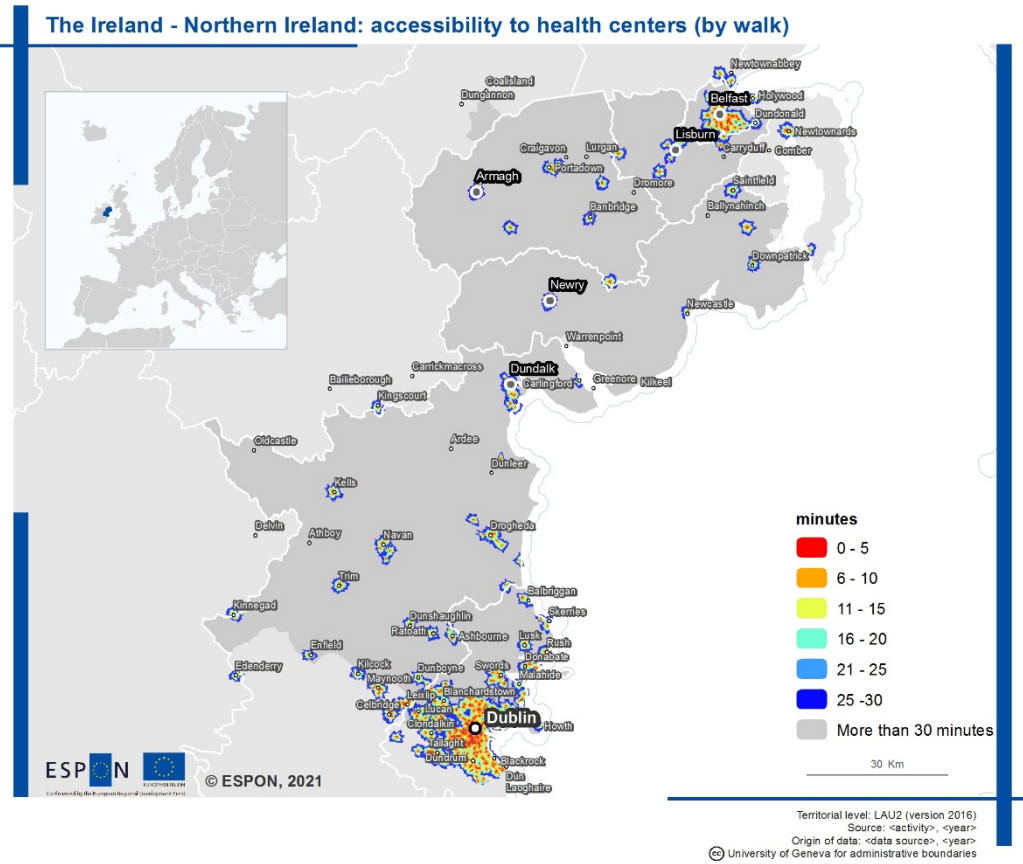


Figure 26: Accessibility to Health Centres by Foot

Data

This map shows the accessibility to health centres, measured as the required walking time from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

The accessibility by foot suggests that most of the region cannot reach a health centre by walking highlighting the high level of car dependency for much of the region.

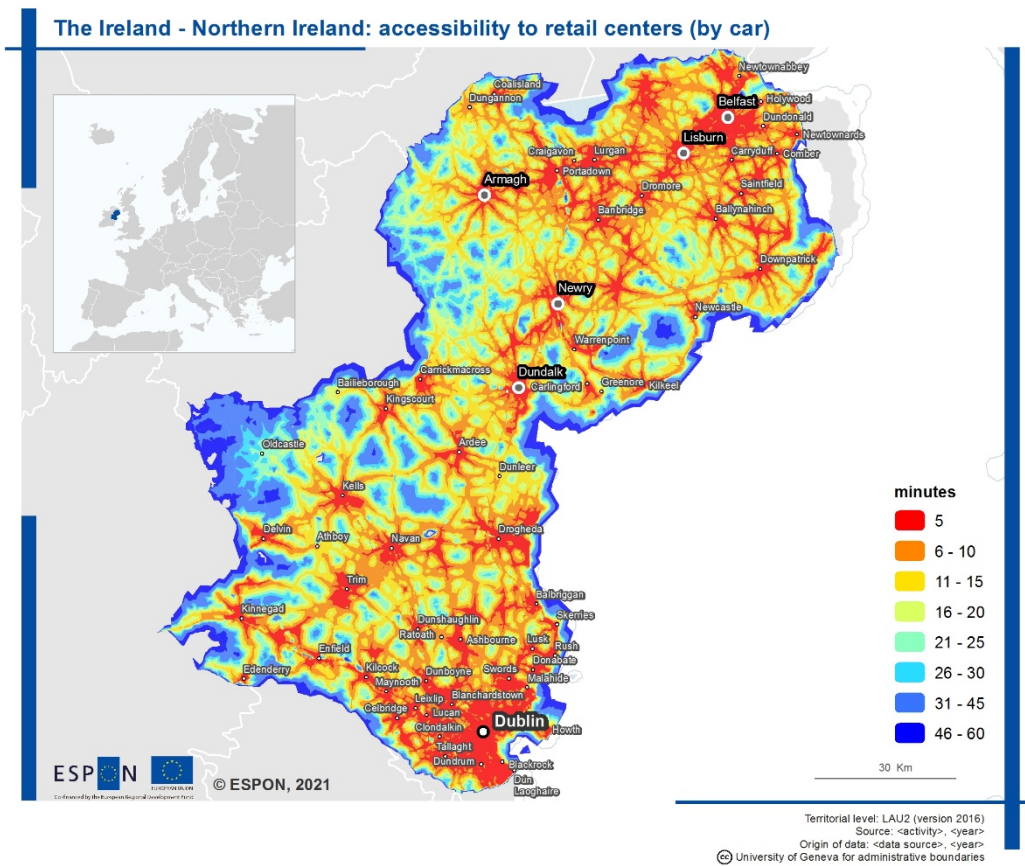


Figure 27: Accessibility to Commercial Centres

Data

This map shows the accessibility to retail shops, measured as the required driving time by car from any point in the analysed area to the nearest shop. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Most of the case study region shows good to average accessibility to commercial centres by car. The inland rural areas often have longer travel times to reach a commercial centre as retail viability is weaker in these less populated areas.

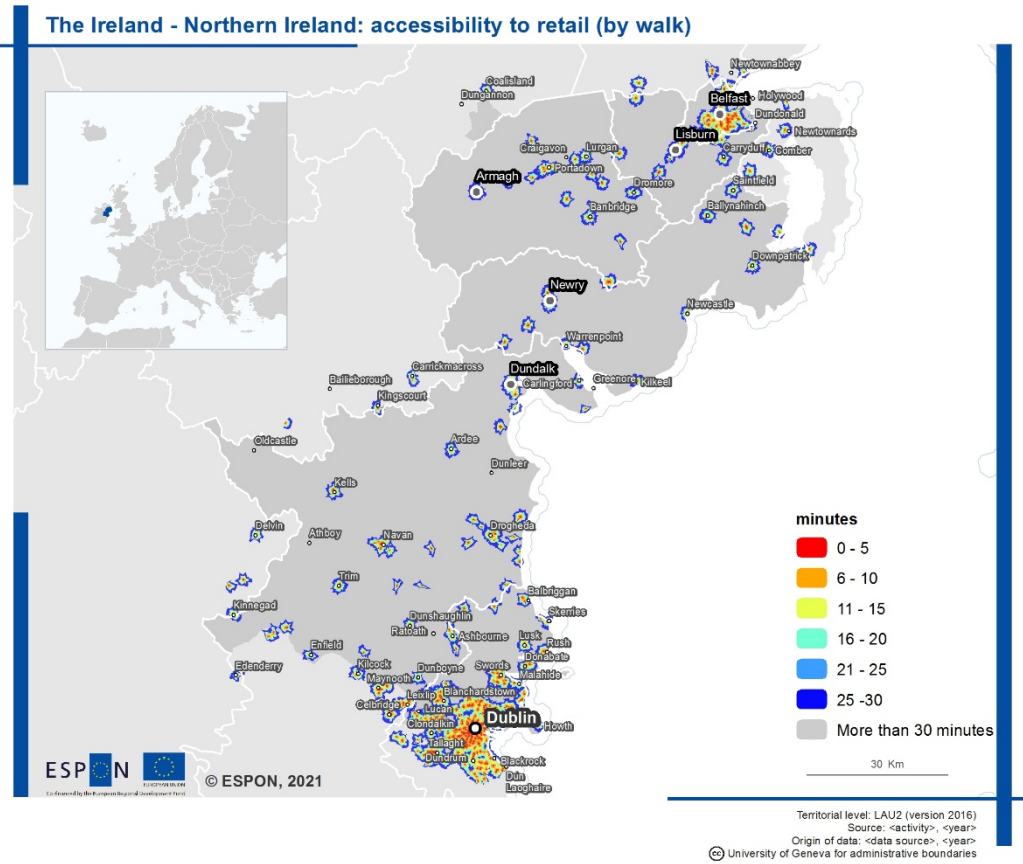


Figure 28: Accessibility to Commercial Centres by Foot

Data

This map shows the accessibility to retail shops, measured as the required walking time from any point in the analysed area to the nearest shop. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

The accessibility by foot suggests that most of the region cannot reach a commercial centre by walking highlighting the car dependency for much of the region.

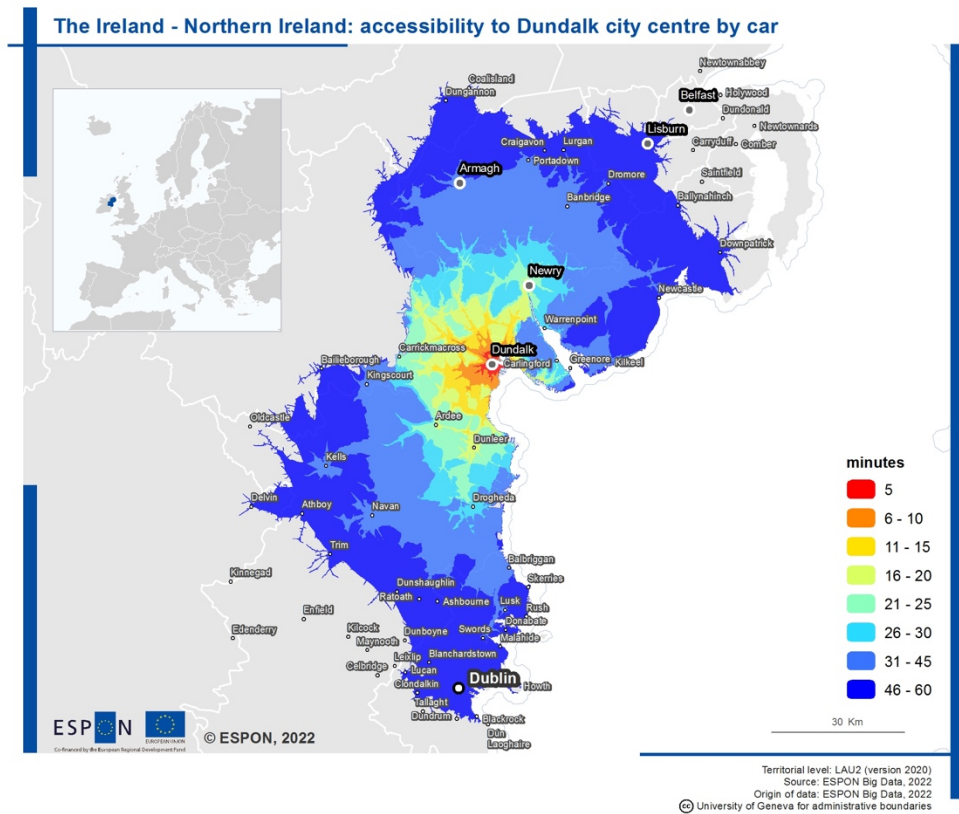


Figure 29: Accessibility to Employment Centres – Irish side

Data

This map shows the accessibility to employment (using city centres as a proxy), measured as the required driving time by car from any point in the analysed area to the city centre in Dundalk. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

In this accessibility map, we observe how the infrastructure for private vehicles is significantly more accessible than the infrastructure for public transport. The cross-border town of Newry is only a 15-to-20-minute drive from Dundalk. Hence, cross-border travel by car is the strongest option for travel within the Irish border region and is a strong factor for encouraging cross-border flows.

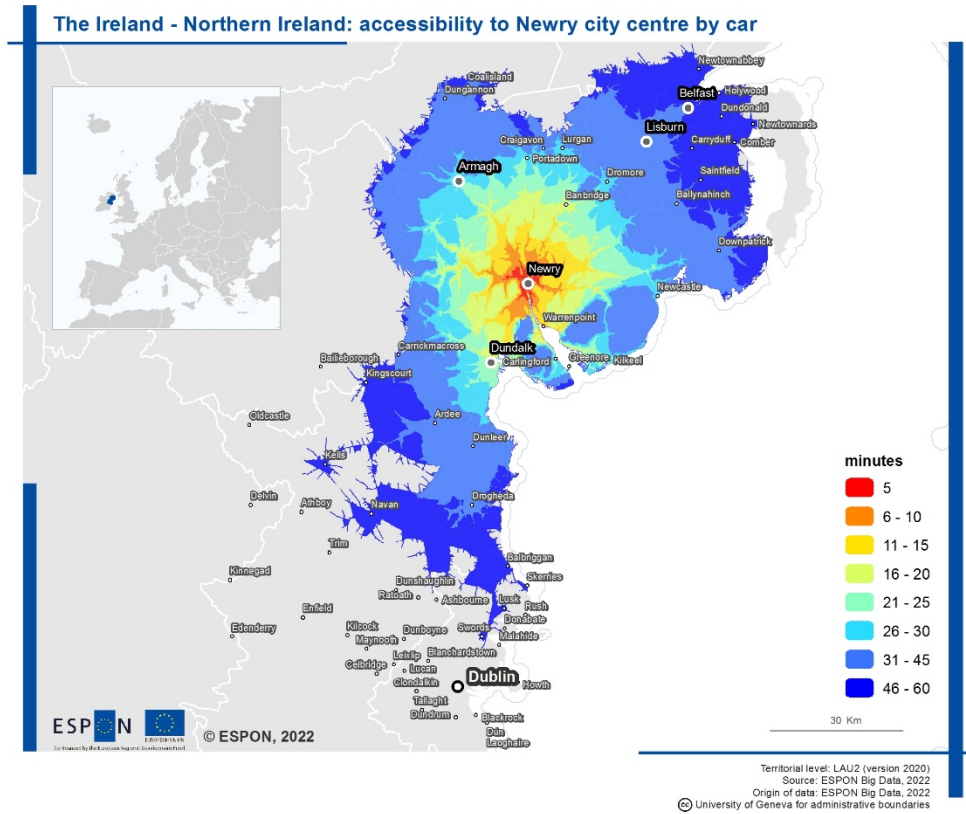


Figure 30: Accessibility to Employment Centres – Northern Ireland side

Data

This map shows the accessibility to accessibility to employment (using city centres as a proxy), measured as the required driving time by car from any point in the analysed area to the city centre in Newry. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Similar to Figure 29, this map displays how Newry is within close proximity to Dundalk and how the Irish border is less than a ten-minute drive from Newry town centre. Hence, we can see how car dependence features as a crutch for further growth and development of this functional cross-border region.

3.4 Spain-France

Summary

This region is characterised by an extensive urban corridor connecting both large urban agglomerations with smaller towns and coastal villages. Despite mountainous geographic features limiting infrastructural links over the border to a few accessible places, this region has high connectivity due to investments and collaborations between governments enabling numerous and frequent transport links which effectively integrate the functional cross-border area. As a result, inhabitants are more easily able to traverse across the entirety of the Basque region due to its strong infrastructure links and high connectivity. As a consequence, we can characterise this functional cross-border area as a well-integrated accessible region due to its focus on encouraging cross-border movements.

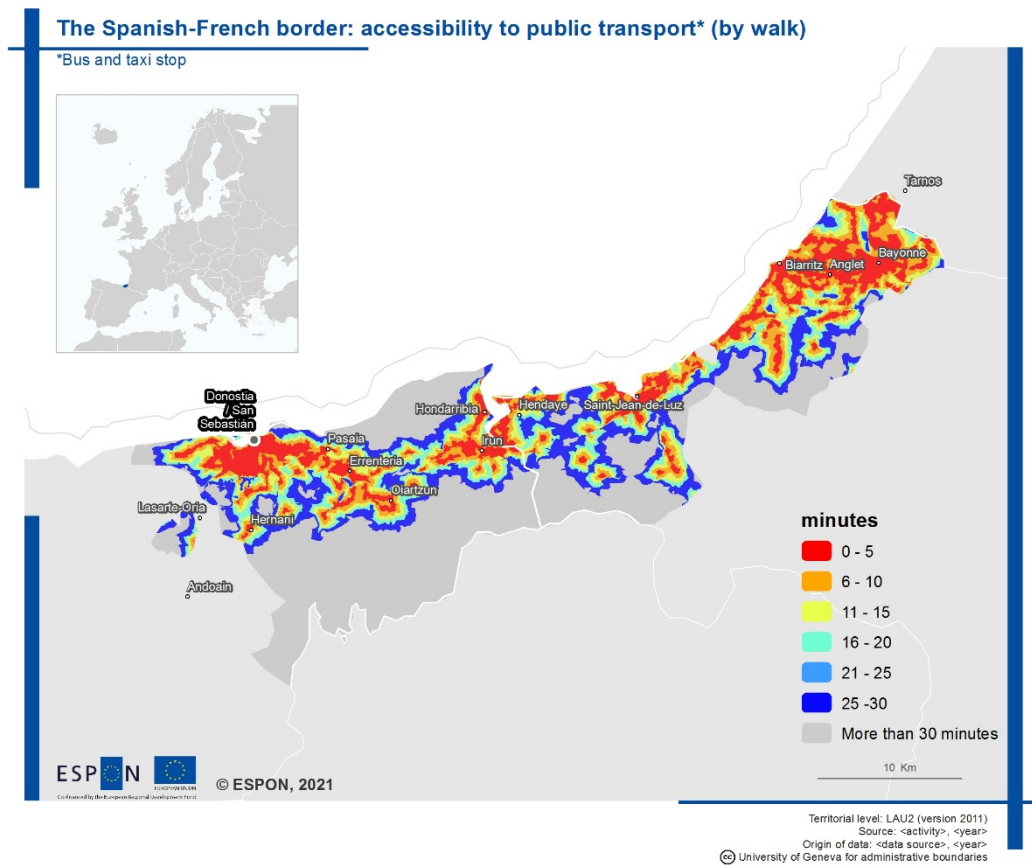


Figure 31: Accessibility to Public Transport

Data

This map shows the accessibility to public transport bus and taxi stops, measured as the required walking time from any point in the analysed area to the nearest stop. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

In terms of accessibility to public transport, this cross-border region is well serviced by bus services. Only in certain more rural and mountainous areas is public transport inaccessible, but across all built-up areas, these is walkable access to public transport reducing the need for car dependency.

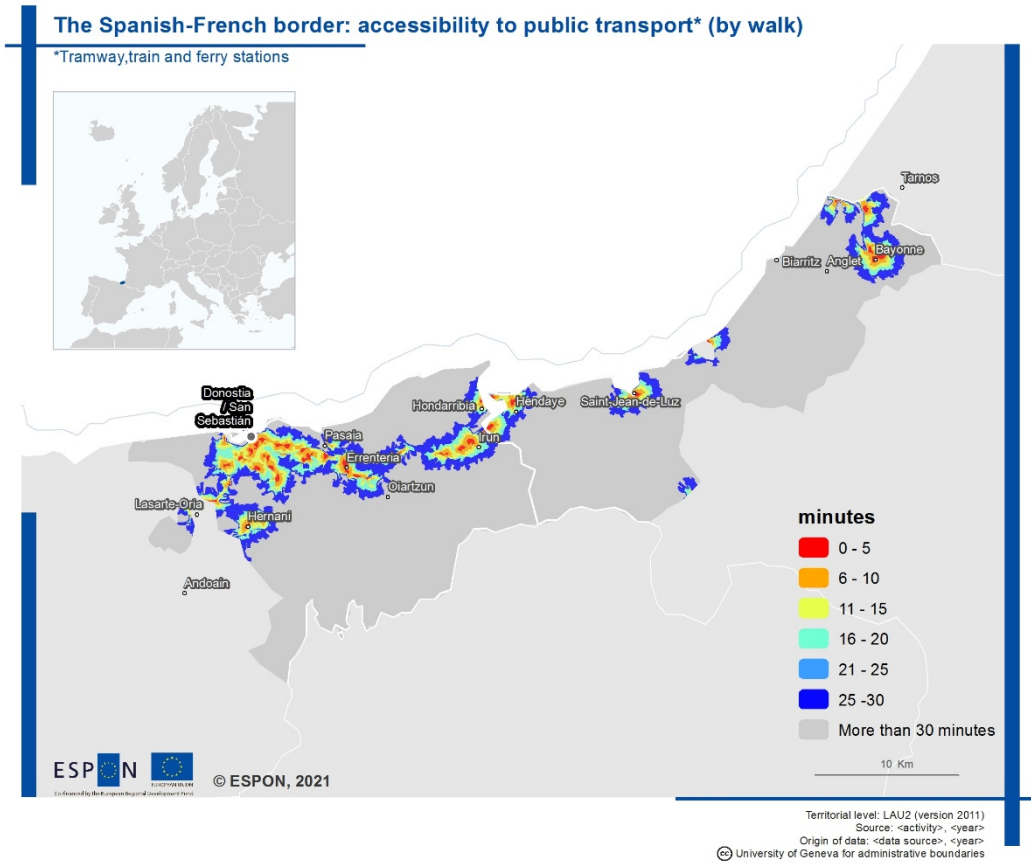


Figure 32: Accessibility to Public Transport (Rail)

Data

This map shows the accessibility to public transport tramway, train and ferry stations, measured as the required walking time from any point in the analysed area to the nearest station. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

While less of the region is accessible to public transport by foot for trains and tramways, the coast corridor between San Sebastian and Biarritz/Bayonne is clearly delineated with train stops in most towns. In Spain, there are more train stations than in France indicating better accessibility in Spain over France for transport by train.

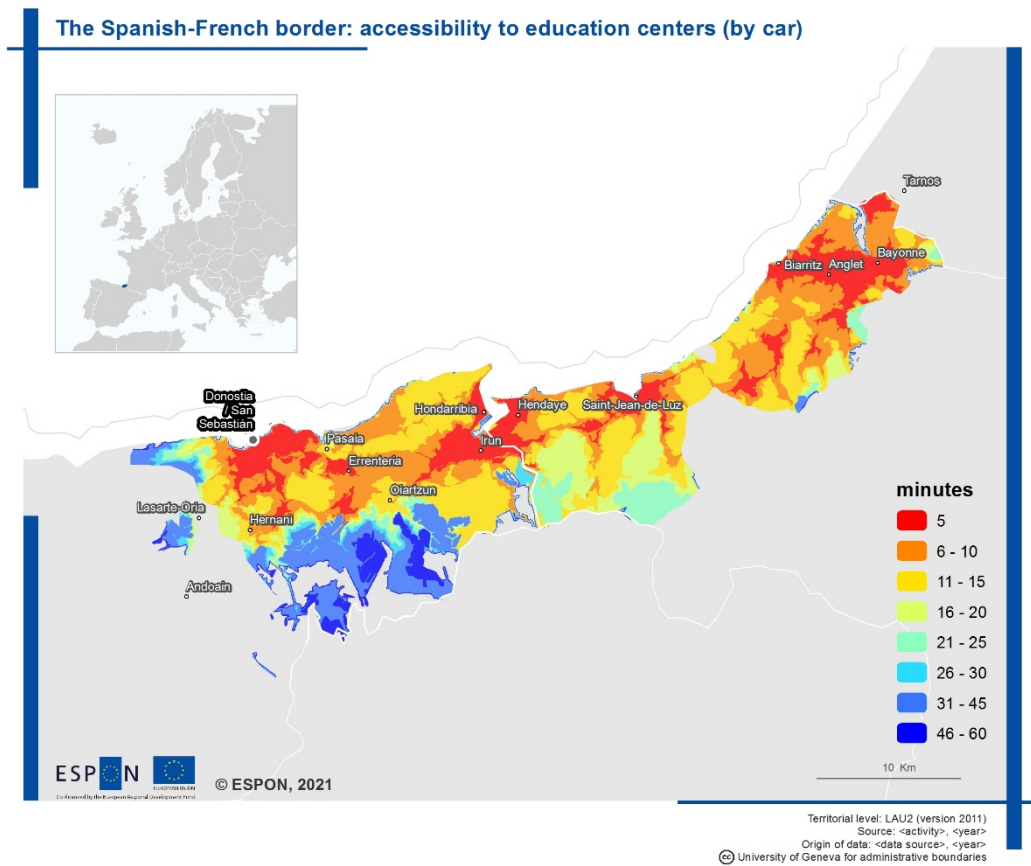


Figure 33: Accessibility to Education Centres

Data

This map shows the accessibility to education centres, measured as the required driving time by car from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns,

Most of the region has strong accessibility to education centres by car with only some inland, mountainous rural regions requiring longer than a 30-minute drive.

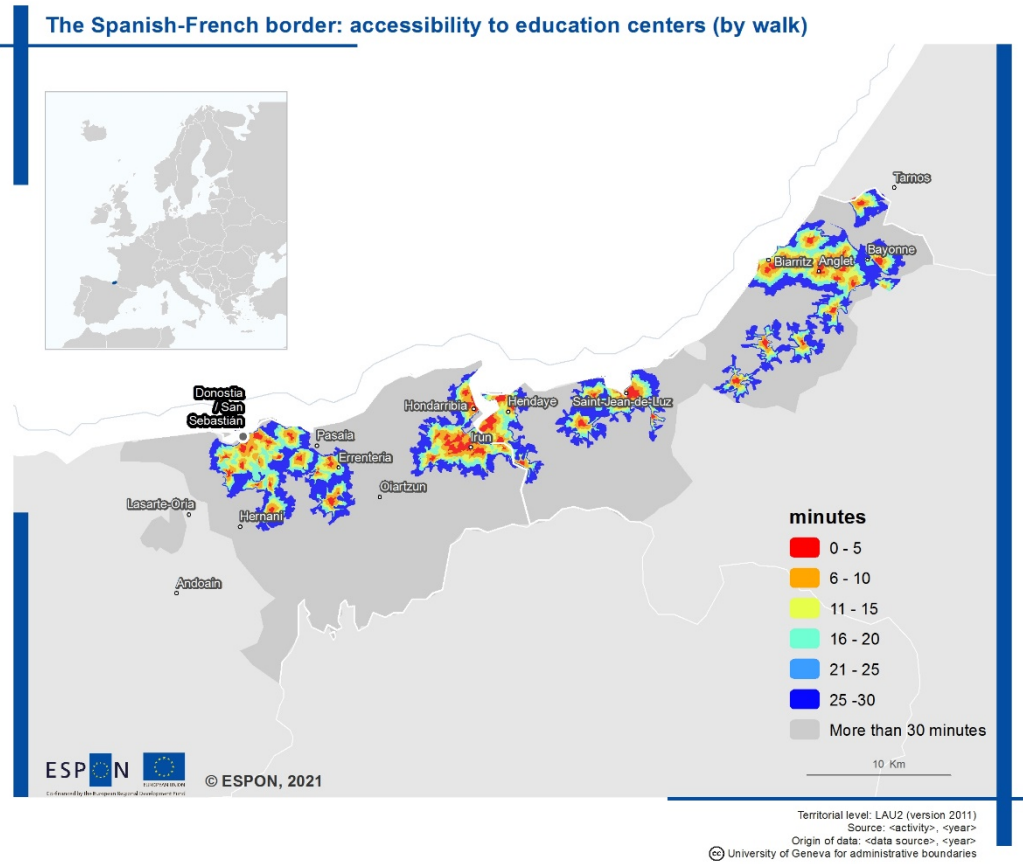


Figure 34: Accessibility to Education Centres by Foot

Data

This map shows the accessibility to education centres, measured as the required walking time from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Much of the region is not serviced by education centres by foot. This illustrates a significant divide between walking and driving where the region is highly connected by road yet has significantly less connectivity for pedestrians.

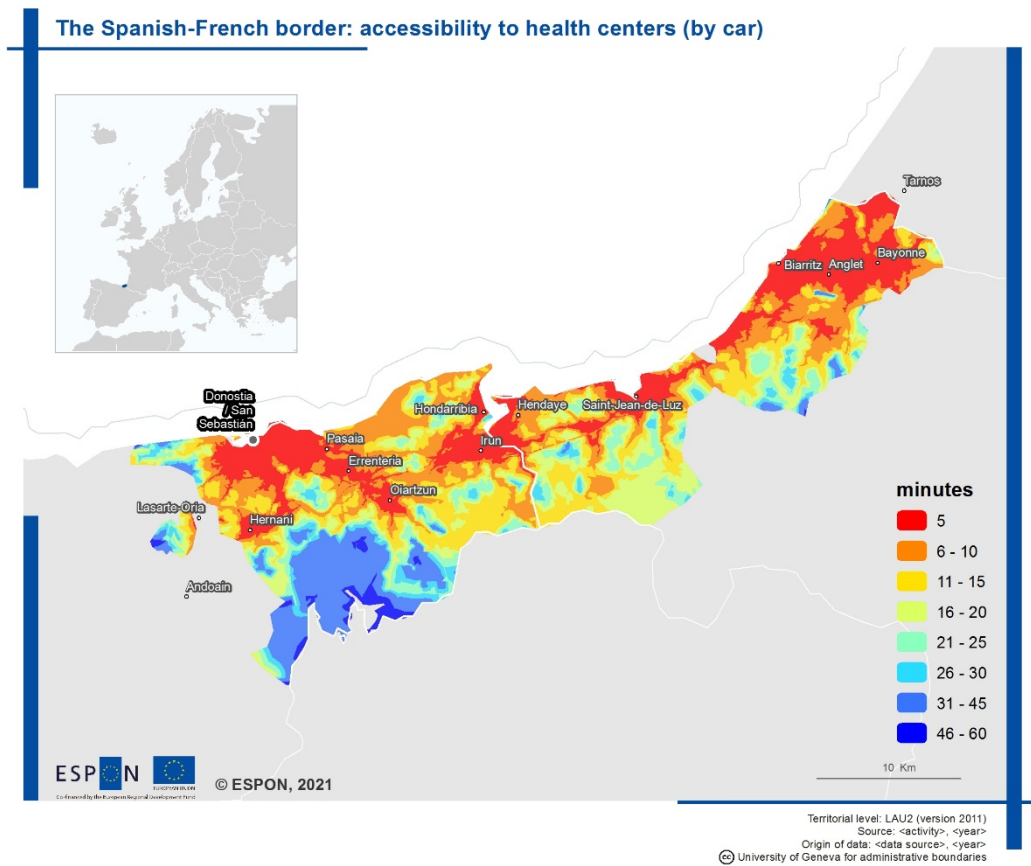


Figure 35: Accessibility to Health Centres

Data

This map shows the accessibility to health centres, measured as the required driving time by car from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Most of the region has strong accessibility to health centres by car with only some inland, mountainous rural regions requiring longer than a 30-minute drive.

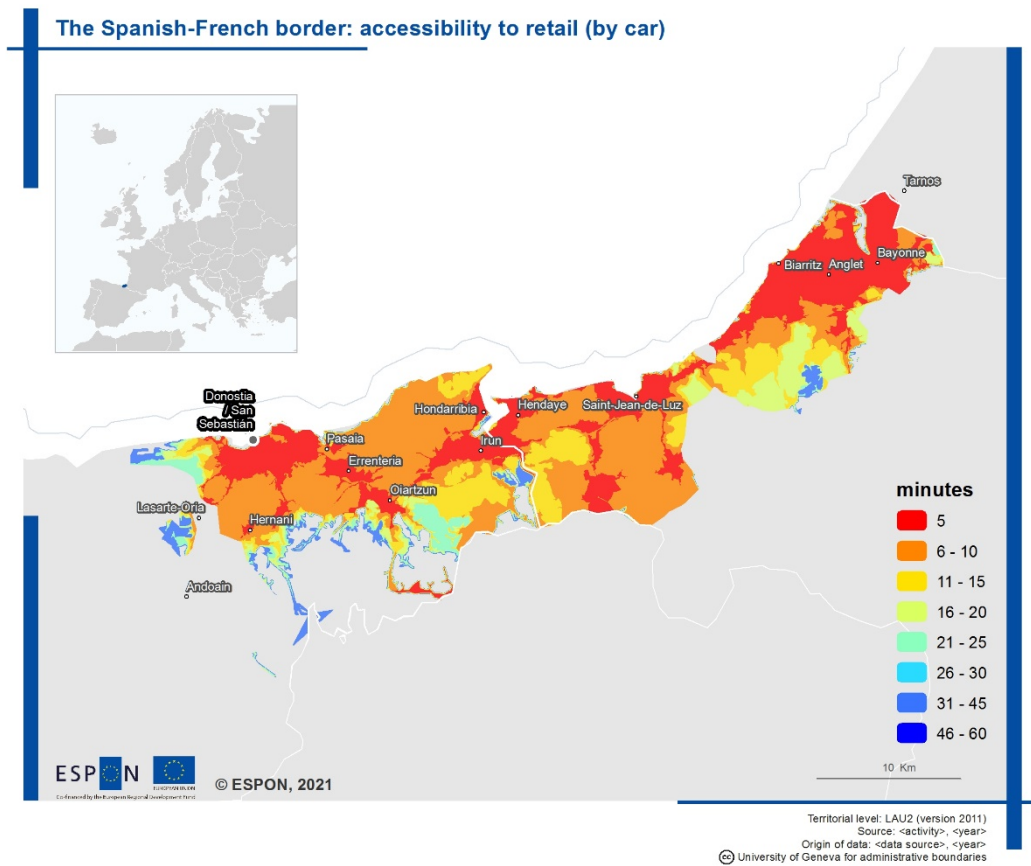


Figure 37: Accessibility to Commercial Centres

Data

This map shows the accessibility to retail shops, measured as the required driving time by car from any point in the analysed area to the nearest shop. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

This region has excellent accessibility to commercial centres by car where almost all of the region can access commercial centres in less than 30 minutes.

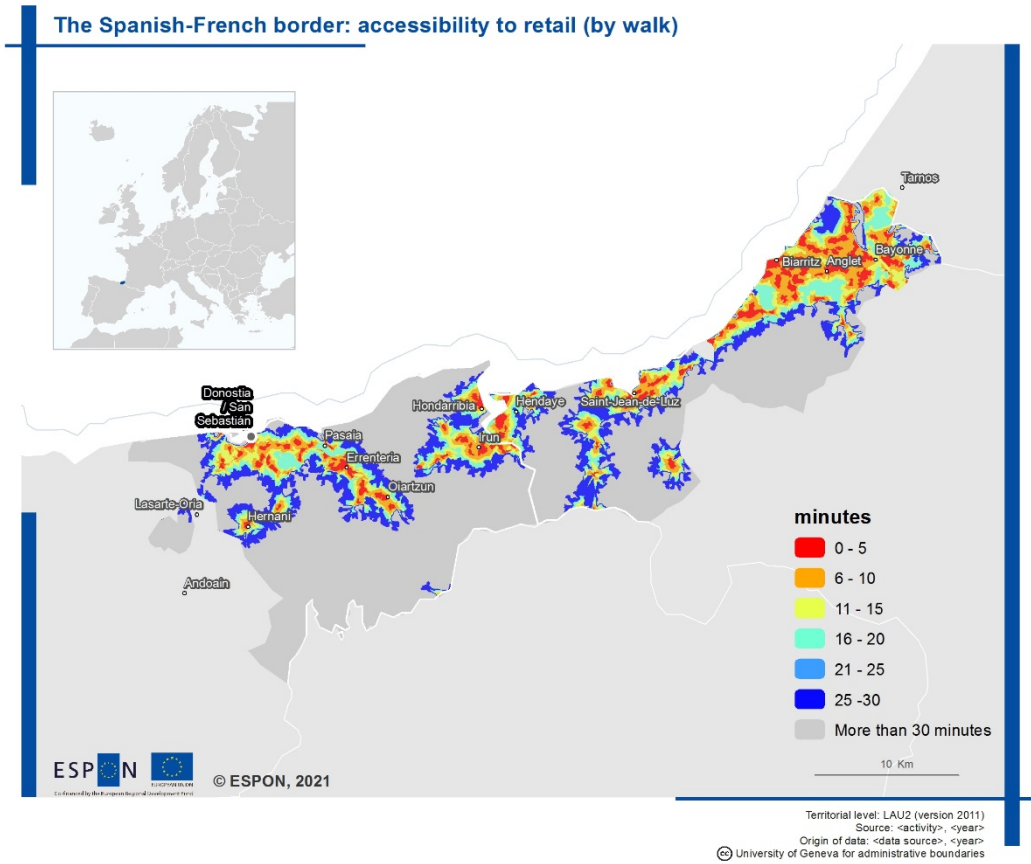


Figure 38: Accessibility to Commercial Centres by Foot

Data

This map shows the accessibility to retail shops, measured as the required walking time from any point in the analysed area to the nearest shop. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

The accessibility by foot suggests that most of the region cannot reach a commercial centre by walking highlighting the car dependency for much of the region.

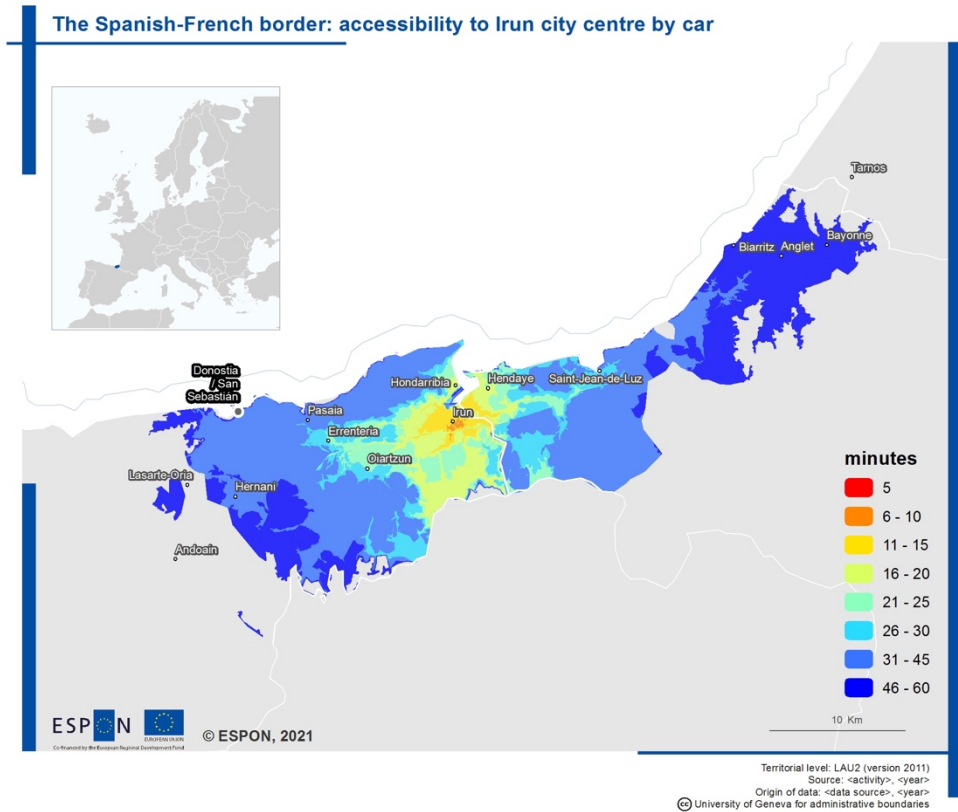


Figure 39: Accessibility to Employment Centres – Spanish side

Data

This map shows the accessibility to accessibility to employment (using city centres as a proxy), measured as the required driving time by car from any point in the analysed area to the city centre in Irun. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Given how Irun, Hondarribia and Hendaye coordinate activity and try to function as one collective city-region, it is unsurprising that all of Hendaye is under a 20-minute commute to central Irun. As Irun functions as an industrial and employment centre within the greater Basque Eurocity, its centrality within this function cross-border region is exemplified in how San Sebastian is only a 30-45 minute drive away while Biarritz and Bayonne are less than an hour's drive away.

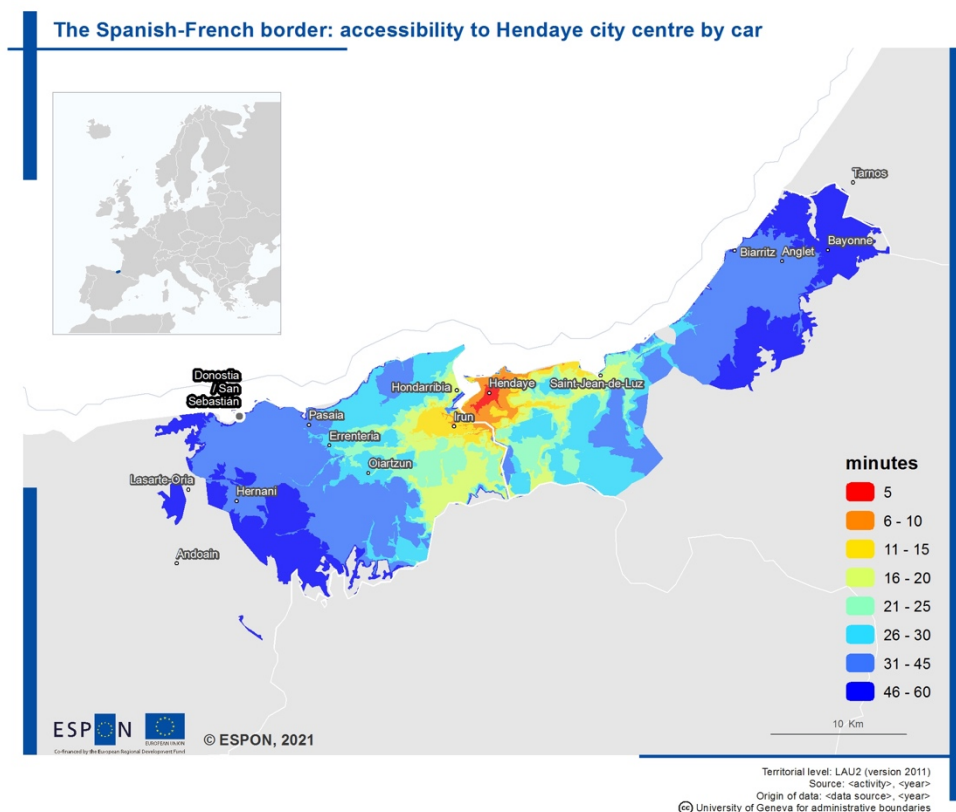


Figure 40: Accessibility to Employment Centres – French side

Data

This map shows the accessibility to accessibility to employment (using city centres as a proxy), measured as the required driving time by car from any point in the analysed area to the city centre in Hendaye. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

As Hendaye is the first French town which all Spanish travellers must pass to reach the rest of the French Basque region and Nouvelle Aquitaine, it is highly accessible across the region. It is less than a 15-minute drive from Irun and less than a 20-minute drive from Hondarribia. Likewise, San Sebastian is less than a 45-minute drive by car. Hence, Hendaye functions as a key connector between France and Spain as all major North-South vehicular travel between the Western France and Northern Spain must pass the town.

3.5 Switzerland-France

Summary

As this case study encompasses the Greater Geneva metropolitan area and the Annecy Functional Urban Area, it has some of the highest levels of accessibility observed throughout the research. At the border specifically, there is an extremely high level of cross-border integration as public transport and infrastructural links allows for high accessibility between French suburbs and central Geneva. Because of its integrated, connected and accessible transport network, we observe that Swiss workers are more motivated to take up housing in France as their dwellings will be in close proximity and have easy access to jobs based in Geneva.

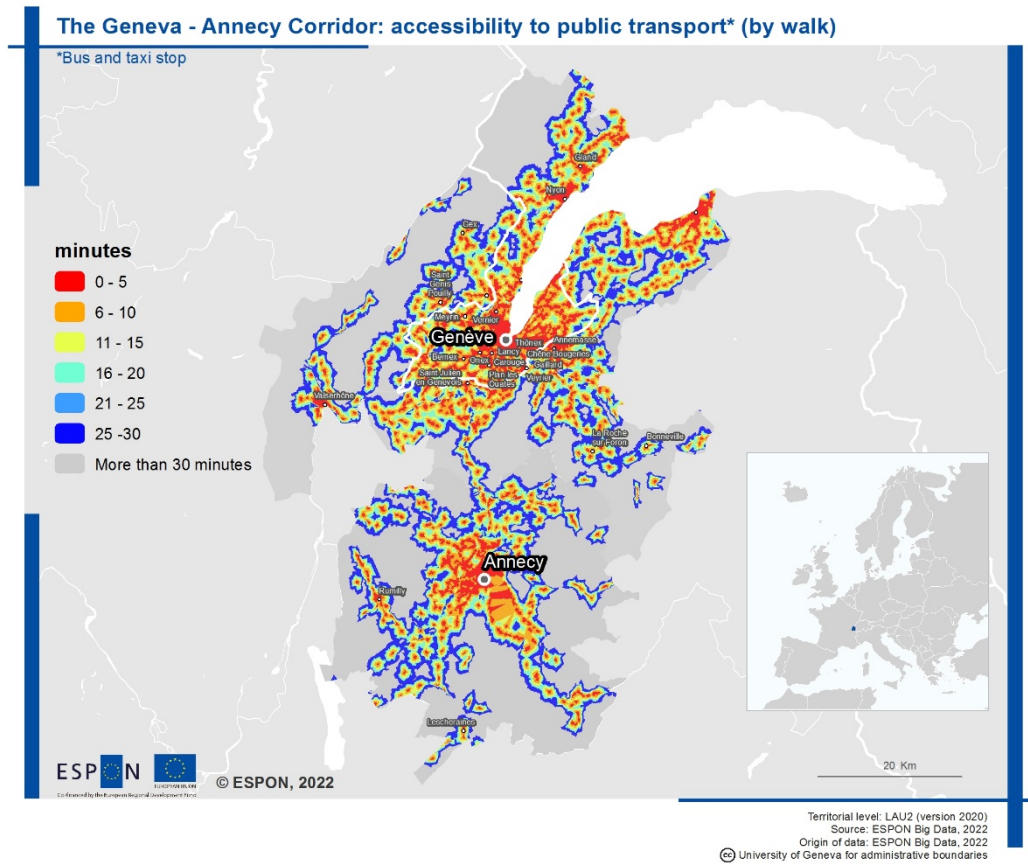


Figure 41: Accessibility by Public Transport

Data

This map shows the accessibility to public transport bus and taxi stops, measured as the required walking time from any point in the analysed area to the nearest stop. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

This map shows very high accessibility for public transport by bus across the region and especially in the built-up areas. Only the very rural mountainous areas outside urban communes have no access to public transport. You can also observe the high degree of connectivity within the Geneva metropolitan area showing how despite the presence of a border, public transport accessibility is still very strong.

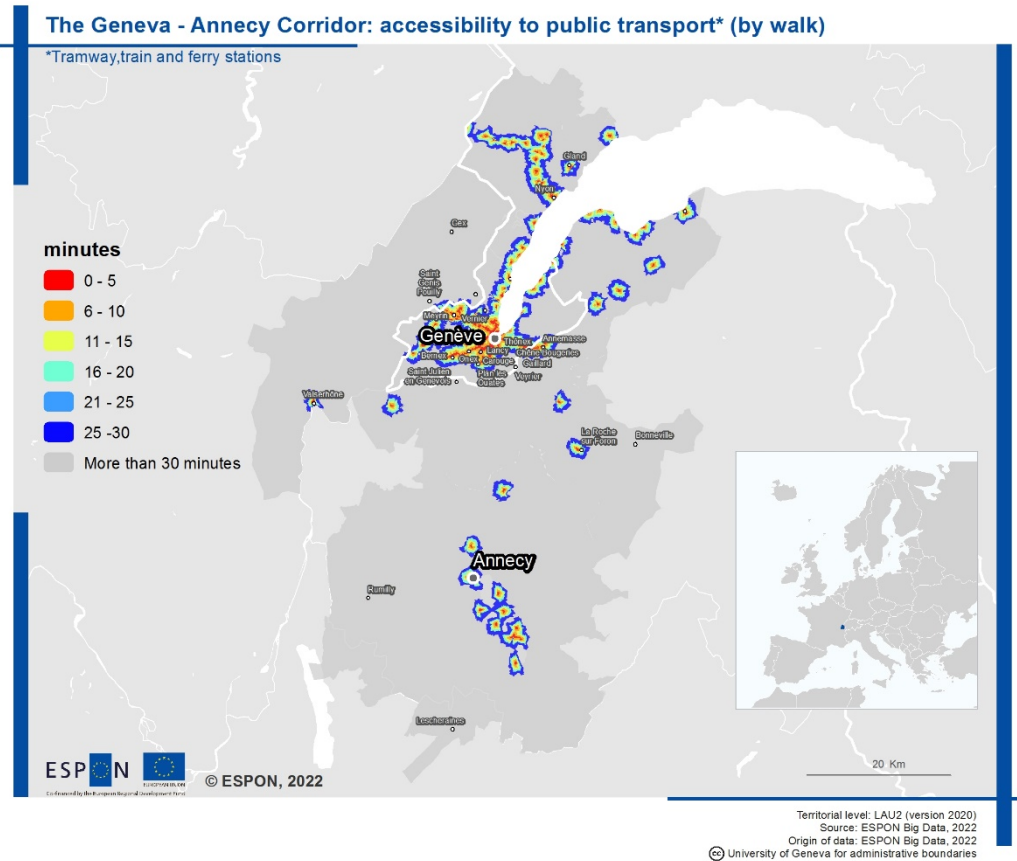


Figure 42: Accessibility by Public Transport (Rail)

Data

This map shows the accessibility to public transport tramway, train and ferry stations, measured as the required walking time from any point in the analysed area to the nearest station. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Contrary to the previous map, Figure 41: Accessibility by Public Transport this map has much poorer connectivity across the region. While there is a substantial rail network within Geneva and Nyon, the rail service does not extend much into metropolitan parts of France. Around Annecy, there are also some train stations but again, the rail service is weaker than that of the accessibility within Geneva and Switzerland.

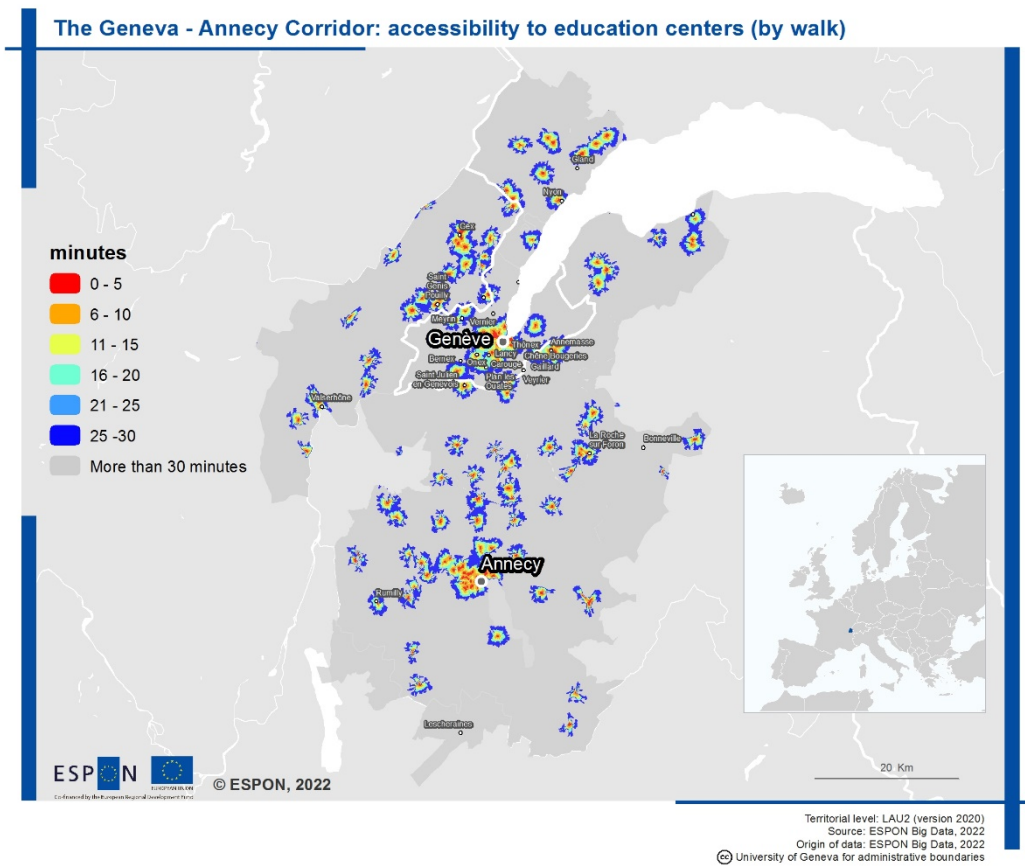


Figure 43: Accessibility to Education Centres by Foot

Data

This map shows the accessibility to education centres, measured as the required walking time from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Overall, much of the region is not able to access an education centre by walking illustrating a greater degree of car dependency for the region, especially in the more rural areas.

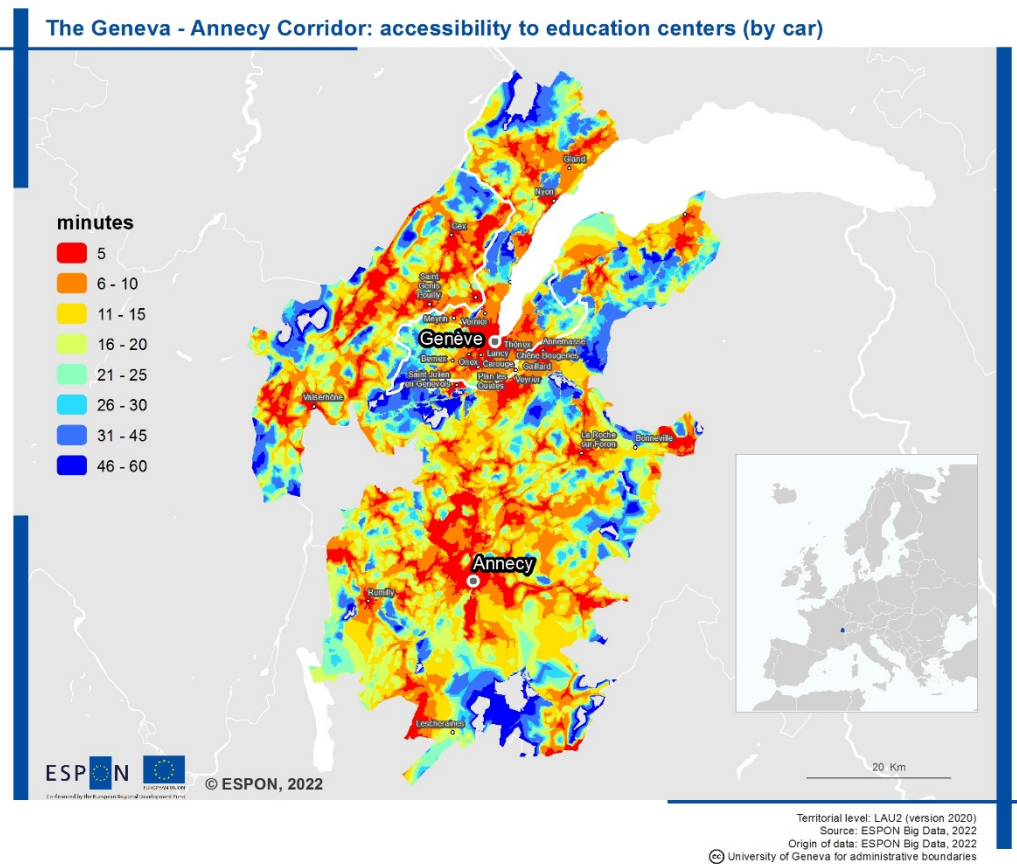


Figure 44: Accessibility to Education Centres

Data

This map shows the accessibility to education centres, measured as the required driving time by car from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Overall, most of the region has high access to an education centre by car with only certain more rural, mountainous regions requiring over 30 minutes of travel to reach an educational centre.

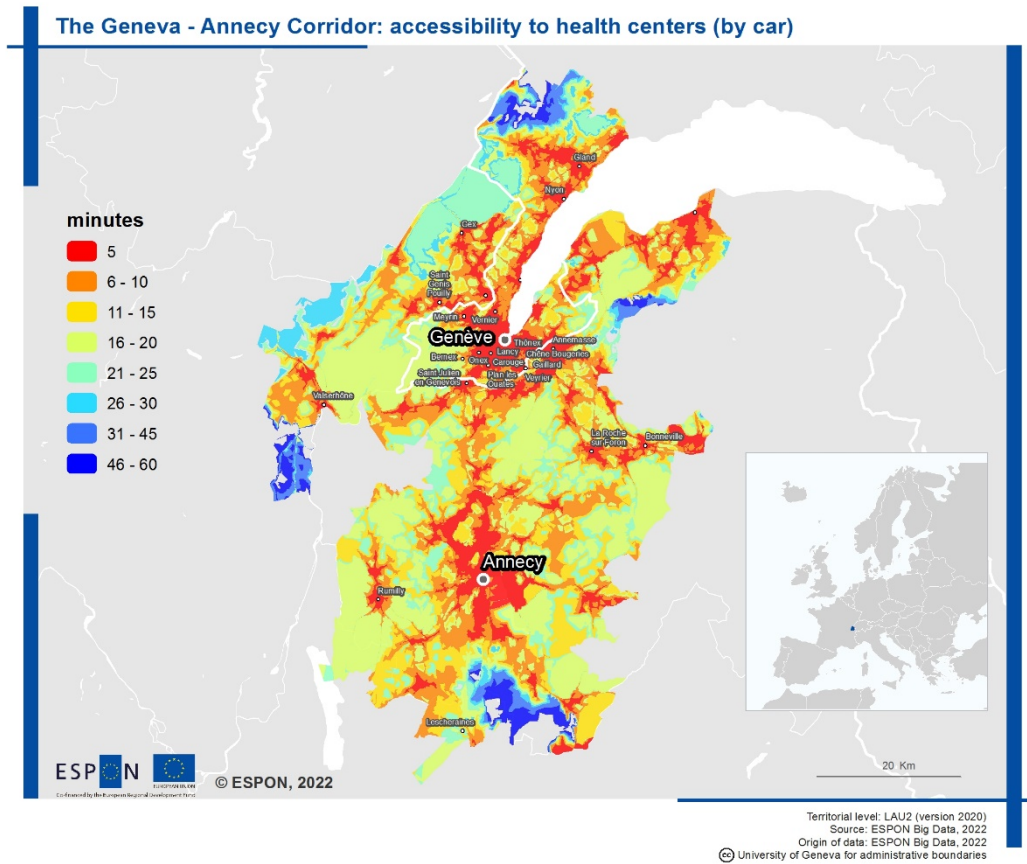


Figure 45: Accessibility to Health Centres

Data

This map shows the accessibility to health centres, measured as the required driving time by car from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Overall, this region has average accessibility to health centres, with most of the health centres being conglomerated in the urban centres. This means that households outside these urban areas have longer travel times to reach a health service, on average about 15 to 25 minutes.

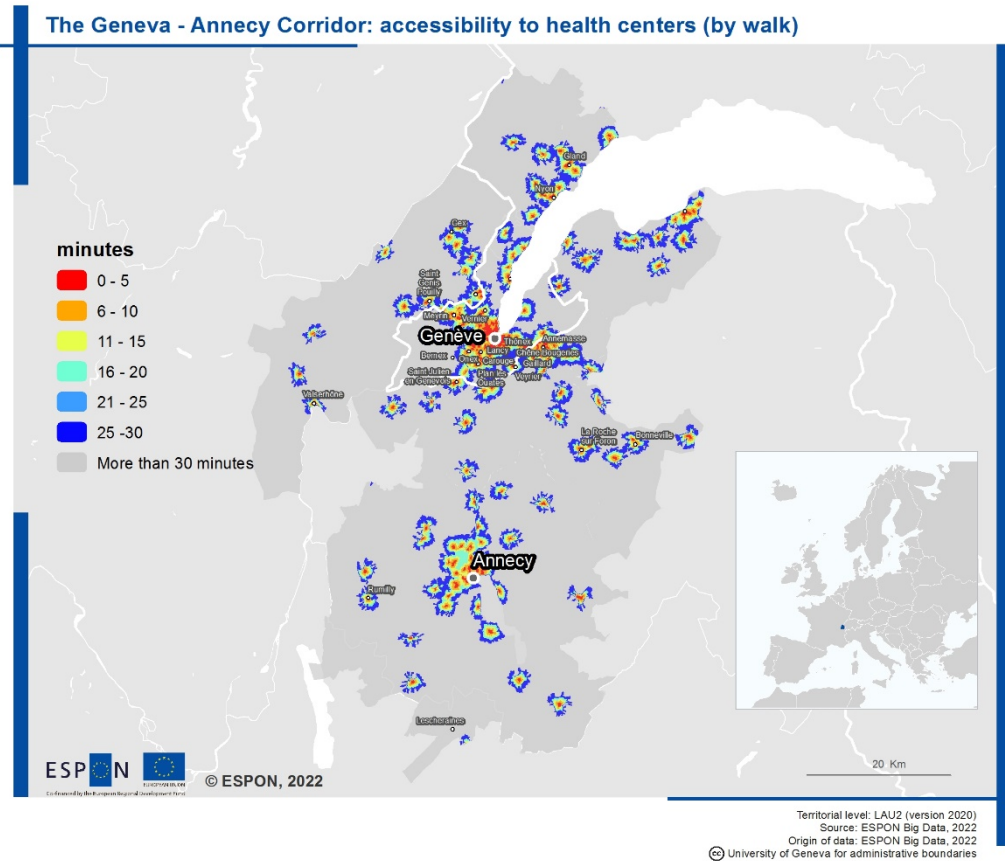


Figure 46: Accessibility to Health Centres by Foot

Data

This map shows the accessibility to health centres, measured as the required walking time from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Again, much of the region is not serviced by health centres within walking distance to home illustrating strong car dependency for the region especially in the rural areas of France and Switzerland.

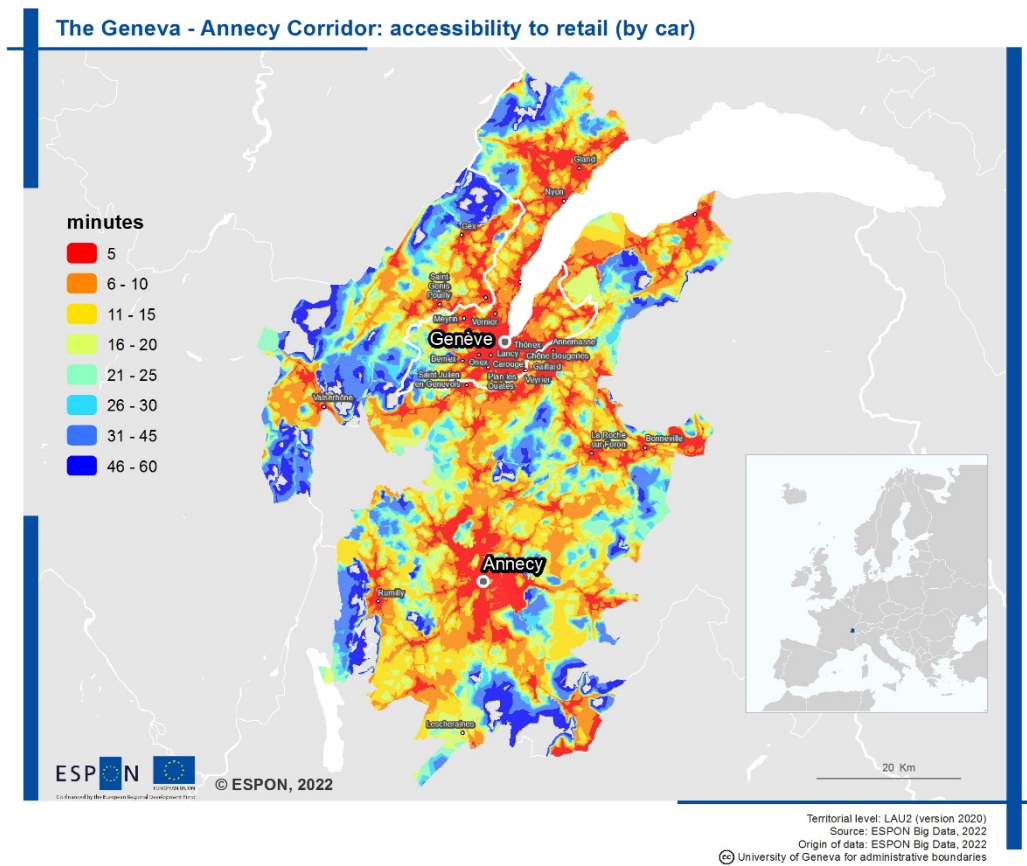


Figure 47: Accessibility to Commercial Centres

Data

This map shows the accessibility to retail shops, measured as the required driving time by car from any point in the analysed area to the nearest shop. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

This region has good access to commercial centres with most of the region able to access a commercial centre in under 30 minutes. Areas requiring longer than 30 minutes are most mountainous and rural.

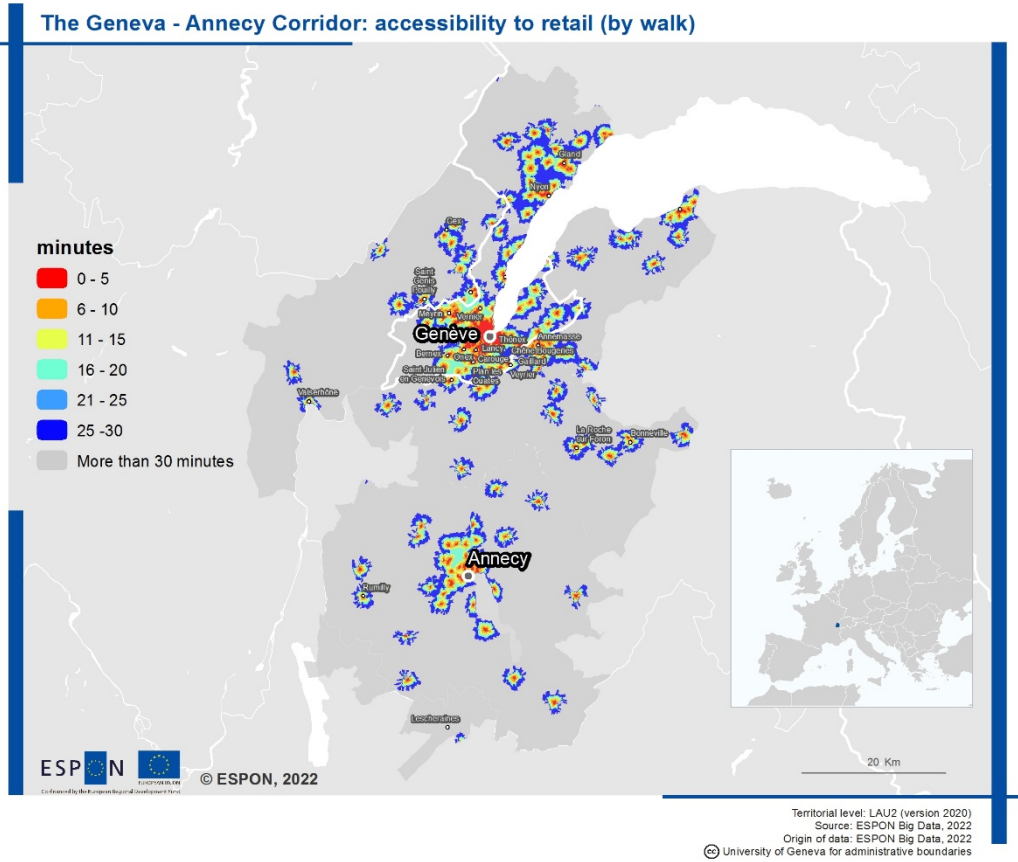


Figure 48: Accessibility to Commercial Centres by Foot

Data

This map shows the accessibility to retail shops, measured as the required walking time from any point in the analysed area to the nearest shop. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

The accessibility by foot suggests that most of the region cannot reach a commercial centre by walking highlighting the car dependency for much of the region.

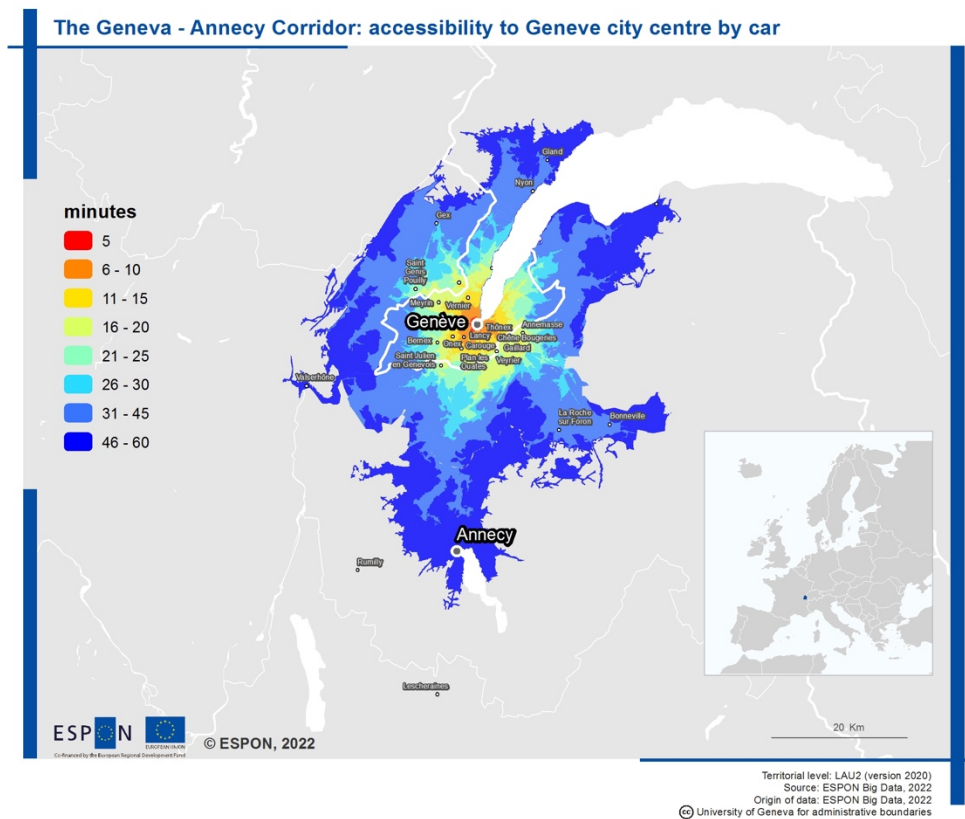


Figure 49: Accessibility to Employment Centres – Swiss side

Data

This map shows the accessibility to accessibility to employment (using city centres as a proxy), measured as the required driving time by car from any point in the analysed area to the city centre in Geneva. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

We can observe from this map that the French commuter towns of Saint Julien en Genevois and Annemasse are about a 15-to-25-minute drive from central Geneva. Hence, their function as residential suburbs of Geneva make sense given its high accessibility both by public transport and by car to central Geneva.

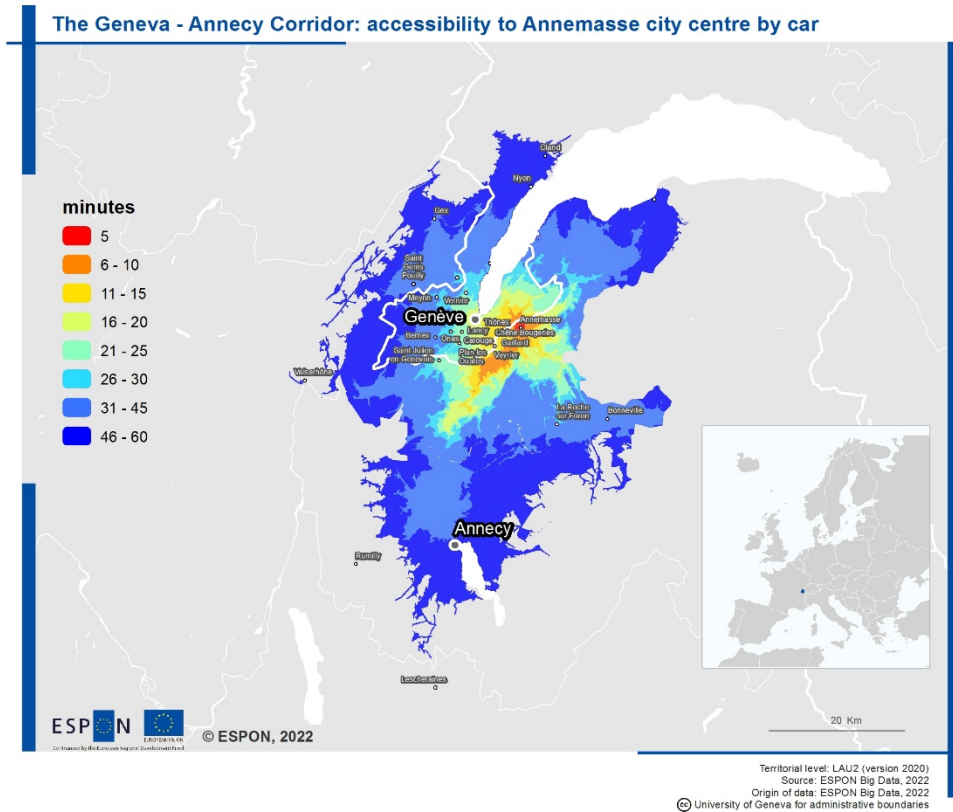


Figure 50: Accessibility to Employment Centres – French side

Data

This map shows the accessibility to employment (using city centres as a proxy), measured as the required driving time by car from any point in the analysed area to the city centre in Annemasse. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

In this map, we observe how Annemasse functions as a regional centre within the Geneva metropolitan area where other French communes have high accessibility to the town while Annemasse itself is only a 15-minute drive from central Geneva.

3.6 Romania-Bulgaria

Summary

Despite close proximity to each, Ruse and Giurgiu have low levels of accessibility and are only connected across the Danube via the Giurgiu-Ruse Friendship Bridge which allows for passenger vehicle, freight and passenger rail connections. Unlike the Greater Copenhagen case study though which is also separated by a body of water, the connections, frequency, convenience, and quality of transport between Giurgiu and Ruse are not amenable to a well-connected, accessible region. Hence, further investment and cross-border collaboration could improve accessibility between the two cities and permit for strong cross-border integration in the future.

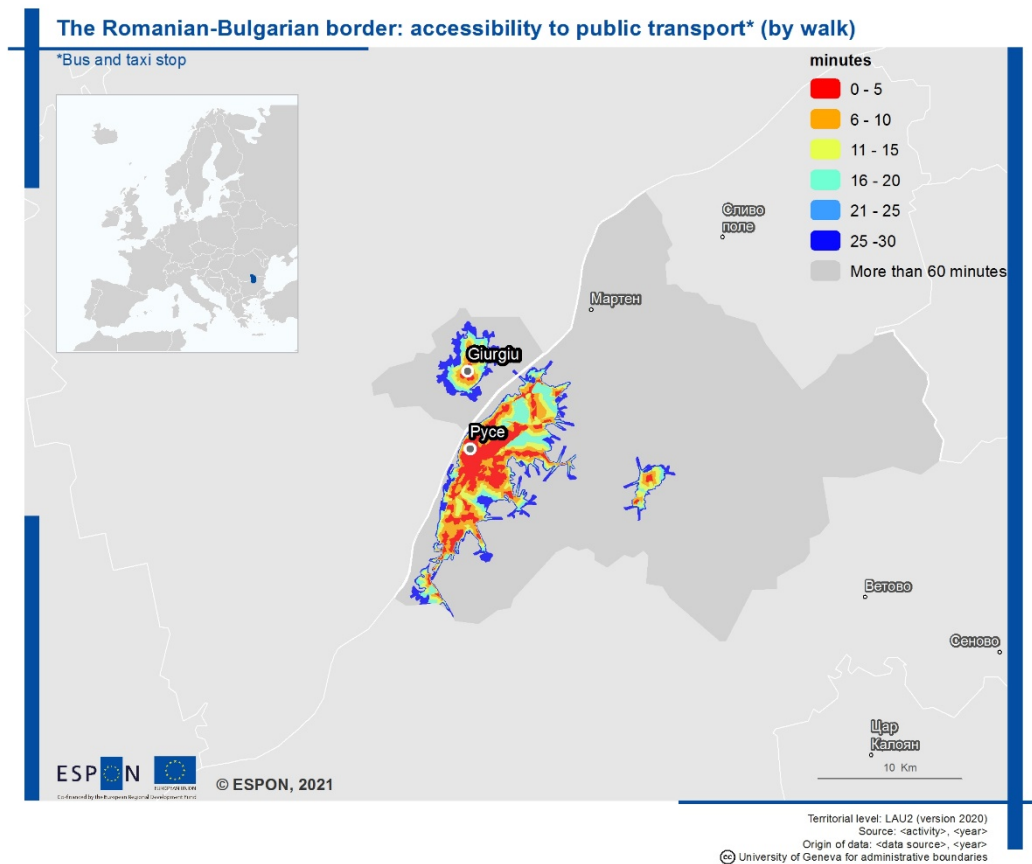


Figure 51: Accessibility Map of Public Transport

Data

This map shows the accessibility to public transport bus and taxi stops, measured as the required walking time from any point in the analysed area to the nearest stop. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Accessibility by public transport is relatively limited within this region and is confined to the built-up areas. Moreover, there is little cross-border connection between the two cities.

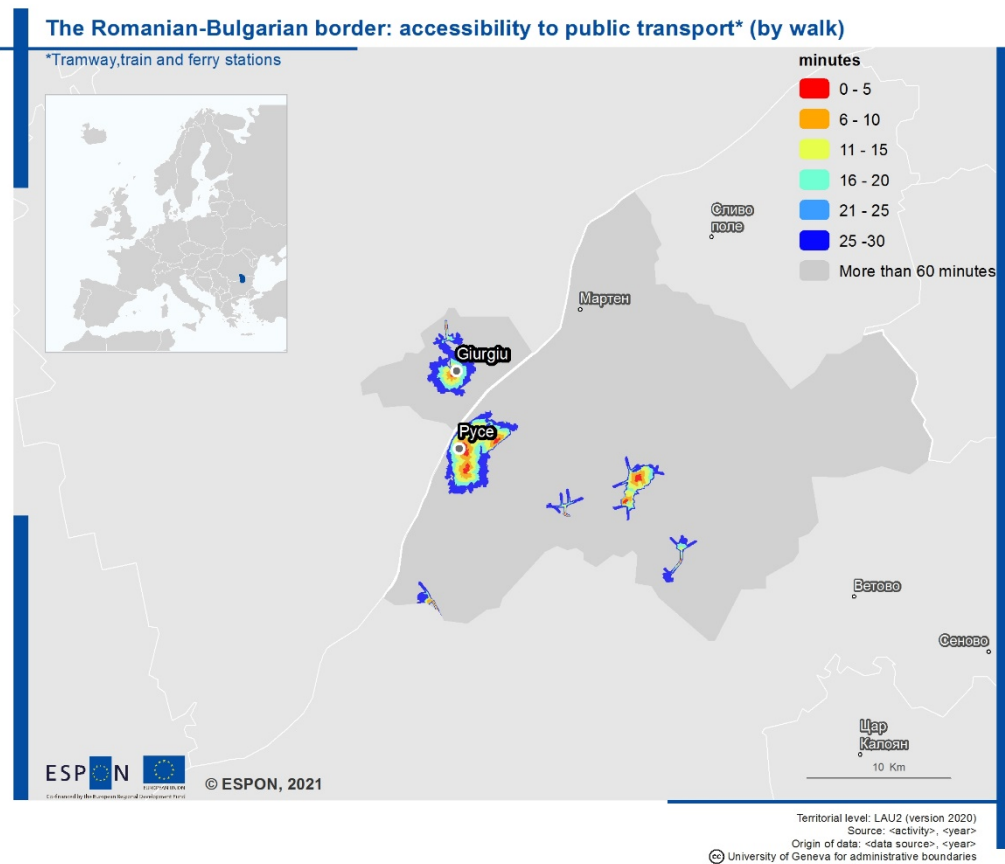


Figure 52: Accessibility of Public Transport (Rail)

Data

This map shows the accessibility to public transport tramway, train and ferry stations, measured as the required walking time from any point in the analysed area to the nearest station. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

There is even less accessibility by rail within this region with only a few areas having access to a train station.

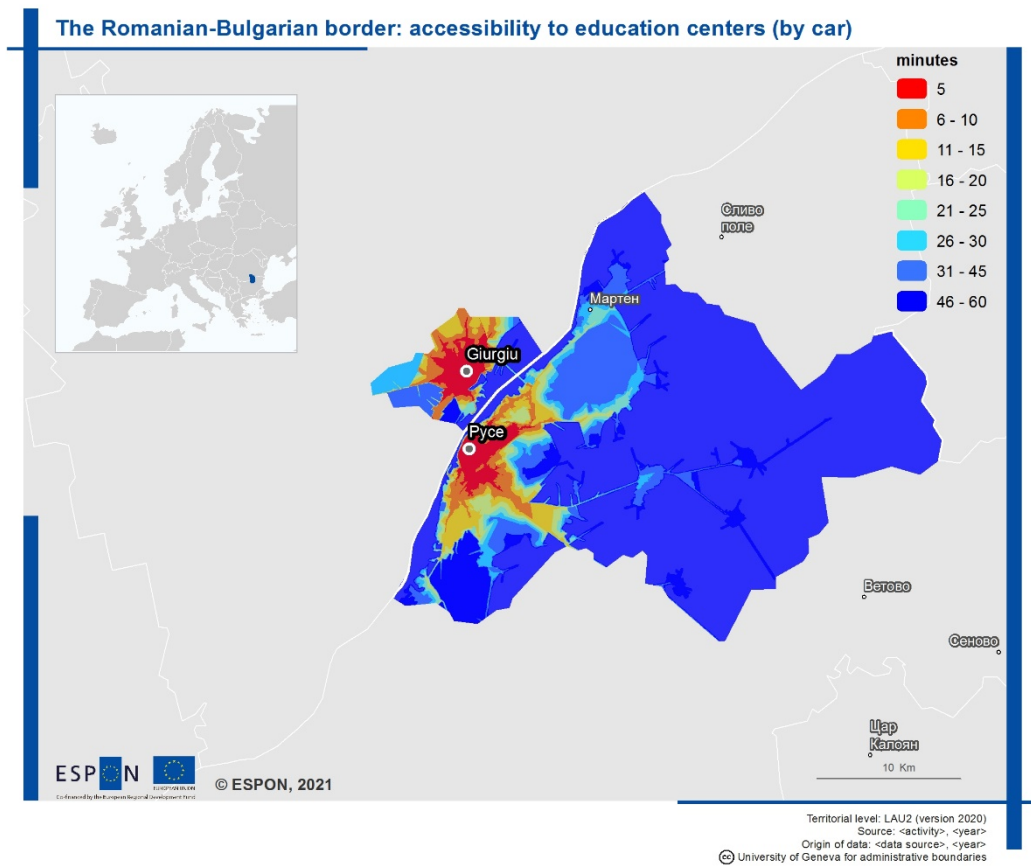


Figure 53: Accessibility to Education Centres

Data

This map shows the accessibility to education centres, measured as the required driving time by car from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

This region is poorly serviced by education centres with only the urban areas having good access to education centres by car.

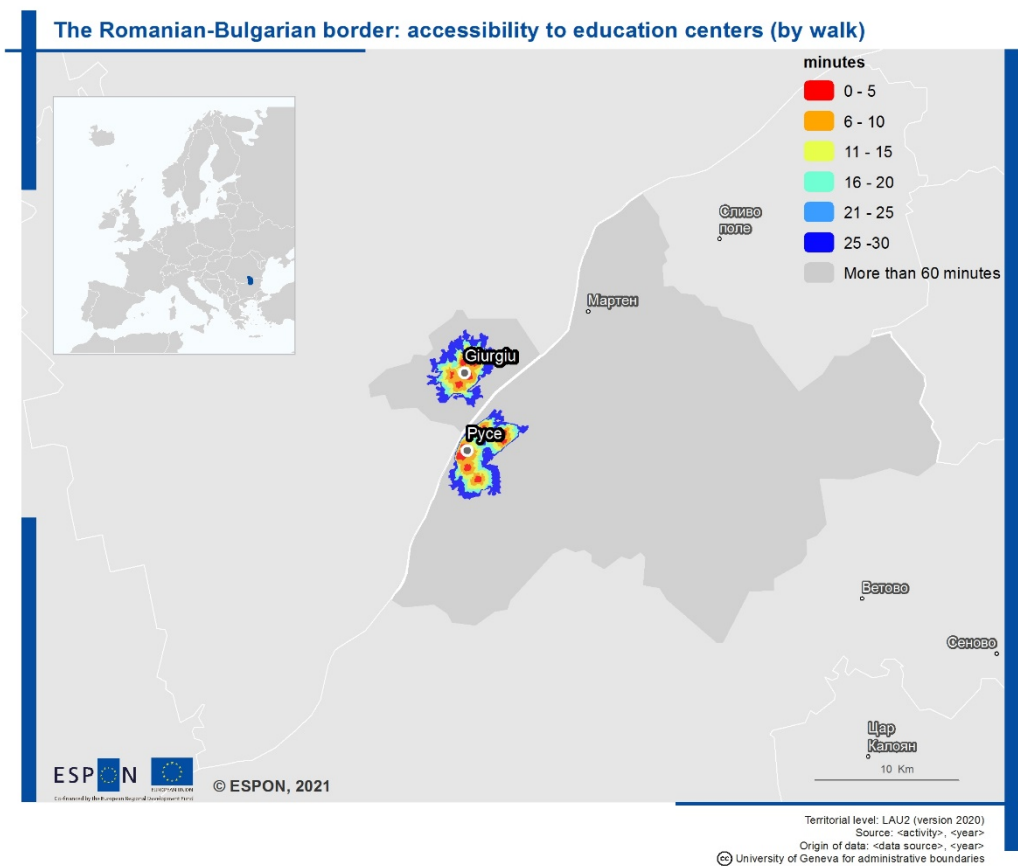


Figure 54: Accessibility to Education Centres (by foot)

Data

This map shows the accessibility to education centres, measured as the required walking time from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Only the urban areas of this region have any access to education centres by walking which highlights the high car dependency of the region.

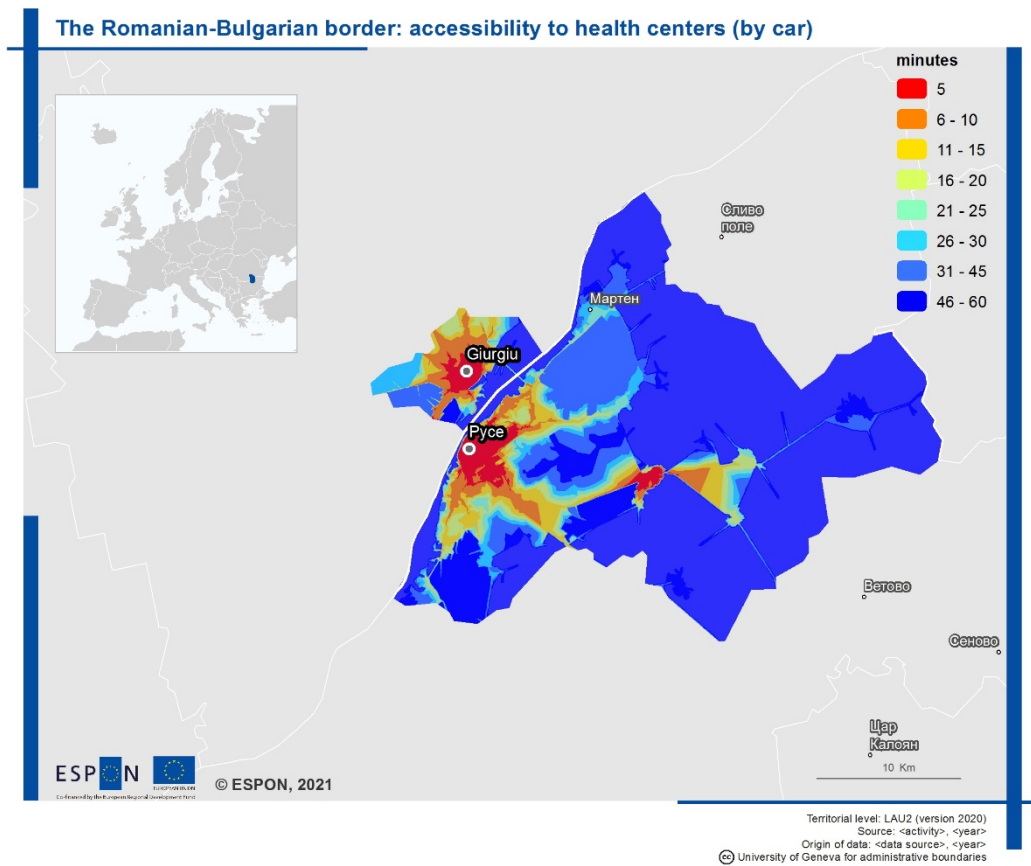


Figure 55: Accessibility to Health Centres

Data

This map shows the accessibility to health centres, measured as the required driving time by car from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

This region is poorly serviced by health centres with the urban areas having the most access to health centres while rural areas require over 45 minutes of travel to reach the nearest health centre.

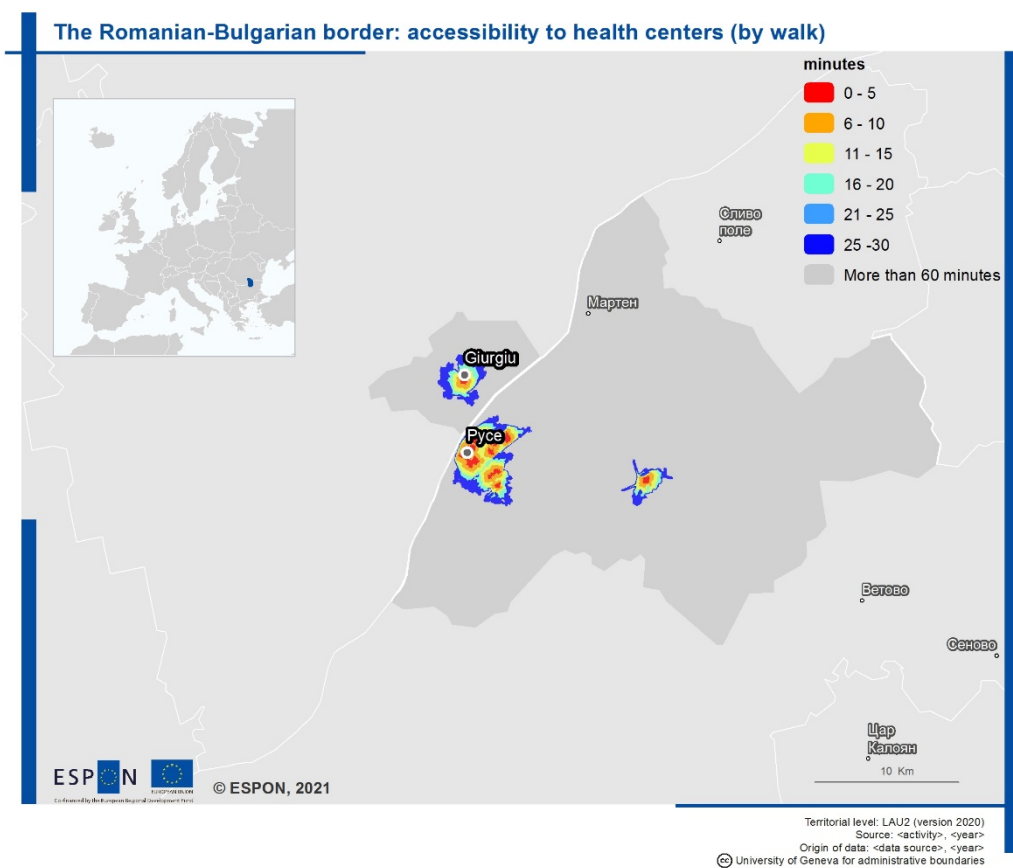


Figure 56: Accessibility to Medical Centres by Foot

Data

This map shows the accessibility to health centres, measured as the required walking time from any point in the analysed area to the nearest centre. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Only parts of the built-up areas of this region have access to health centres by walking which highlights the high car dependency of the region.

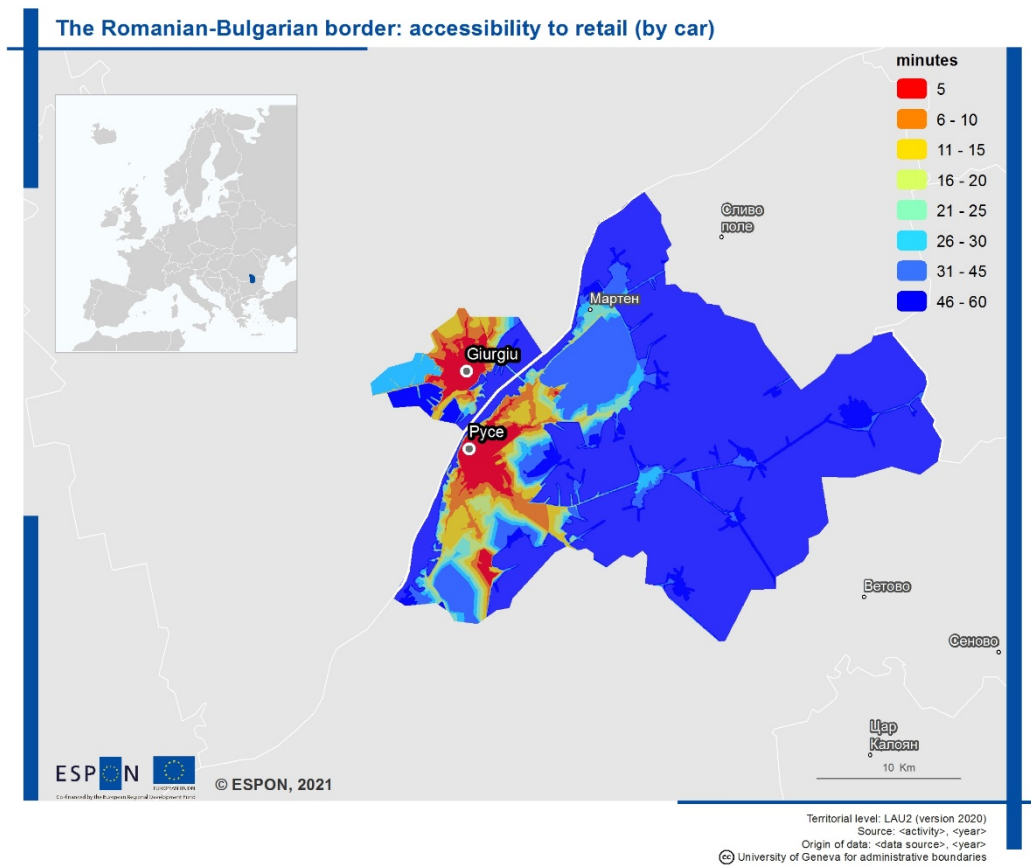


Figure 57: Accessibility to Commercial Centres

Data

This map shows the accessibility to retail shops, measured as the required driving time by car from any point in the analysed area to the nearest shop. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

This region is poorly serviced by commercial centres with the urban areas having the most access to retail while rural areas require over 45 minutes of travel to reach the nearest commercial centre.

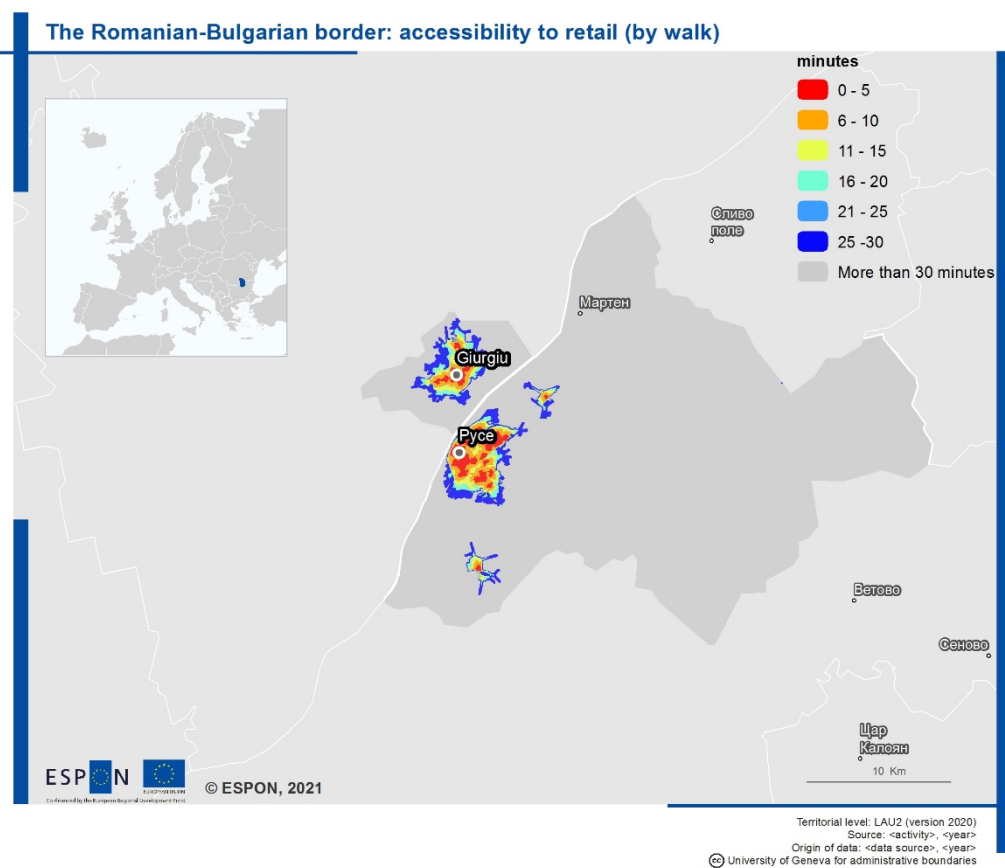


Figure 58: Accessibility to Commercial Centres by Foot

Data

This map shows the accessibility to retail shops, measured as the required walking time from any point in the analysed area to the nearest shop. Results are delivered as isochrones with a 5-minute interval.

Trends and patterns

Only the urban and built-up areas have access to commercial centres by walking. This highlights the car dependency for much of the region especially outside the cities of Ruse and Giurgiu.

4 Future Research

Although the analysis shows that no correlation exists between prices of real estate or rentals with respect to accessibility to services of general interest, it might be good to explore this path more in depth.

First, our suggestion would be to collect more data by scraping with a longer sample, and then perform an analysis by segmenting the advertisements by typology of dwelling, size/number of rooms, facilities offered (parking lot, swimming pool, garden...) as these elements play a much bigger role in setting the price, as well as to identify smaller pockets of sought-after estates.

Once we have the sample properly segmented, one can then look for correlations with the accessibility which might then shed some light on how good access to SGIs can affect the prices in correlation with other amenities such as green places.

Secondly, further one can test different types of accessibility measures including total distance together with the distance to access to public transport.

It is worth mentioning that this type of analysis is valid for specific case studies and cannot be generalised to Europe as a whole. However, in a European overview one might in the long run be able to identify the difference in time people are willing to commute in border regions versus in non-border regions.



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