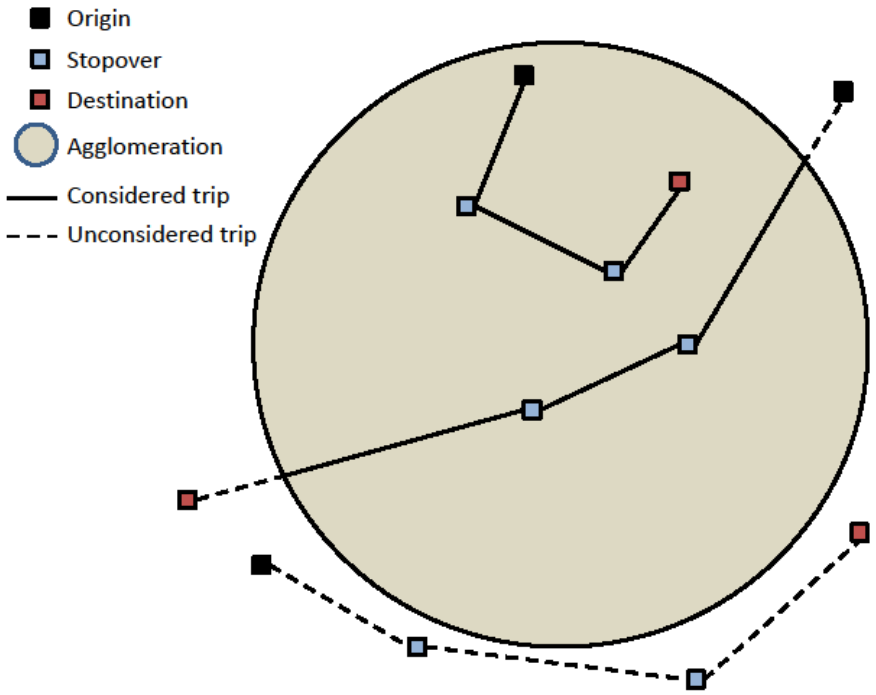

Residential and territorial based analysis of mobility behaviour in Swiss agglomerations

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Abstract

The MCMT (Microcensus on Mobility and Transport) has been conducted since 1974. In 2010, over 62'000 individuals were asked to provide information on various aspects of their travel behaviour. In addition to geo-coded locations of trip origin and destination, additional information on routs for each trip on a specific day were recorded. Besides residential based calculations on annually travelled car and passenger kilometres, these routing data allow territorial based calculations for sub-territories within Switzerland.

The paper introduces both methods, the residential and the territorial based approach, in detail. An analysis on car drivers' behaviour in Swiss agglomerations is used as a case study and thus highlights potentials and limitations of each approach. The territorial based approach is applied for the first time to analyse the travel performance within Swiss sub-territories as there were no routing information available in earlier MCMTs on a national scale.

Both residential and territorial based traffic performances are calculated for the Swiss agglomerations, distinguishing between three road classes. Furthermore, the territorial based approach is used to investigate the importance of transit traffic within the agglomerations. Additional insight is obtained by combining both approaches: The share of car kilometres that agglomeration residents performed within their residential agglomeration as well as the proportion of territorial based agglomeration traffic performed by people living outside an agglomeration are analysed.

Keywords

Residential based analysis, Territorial based analysis, Swiss agglomerations

1. Introduction

The Swiss Microcensus on Mobility and Transport (MCMT) collects information on the mobility behaviour of Swiss residents every fifth year. The 2010 data collection includes two innovations in comparison to earlier MCMT surveys: First, the sample size is increased substantially by encouraging cantons, agglomerations, and cities to provide additional respondents living in their area. Numerous contributions helped to nearly double the sample size. In 2005, 33'390 respondents from 31'950 households filled out the survey instrument, whereas there were 62'868 respondents from 59'971 households in 2010. Second, respondents were asked to report routes for each trip over three kilometres they performed on the recorded day. These routes were assessed to calculate travel distances and do not represent exact routes (for more information see Ohnmacht *et al*., 2012). Earlier MCMT data collections did not include geo-referenced information at all or, in case of the 2005 survey, were limited to geo-referenced points of trip origins and destinations (for more information on the MCMT see BFS, 2012a; for a definition of trips and tours see Axhausen, 2006).

These two innovations, an increased sample size and the availability of precise routing information, allow the calculation of territorial based transportation figures (e.g. kilometres travelled within a specific agglomeration). Because routing information was not at hand, figures on transport performances of Swiss sub-territories were calculated in an residential based way in the past. Residential based information results in figures on the transport performance of an area's residents but clearly includes bias when employed as a proxy for the overall transportation performance within the area. In contrast, territorial based analysis considers all trips that are performed in a specific area. Such information does not substitute residential based information but complements it. Territorial based transport performances have never been calculated for Swiss sub-territories before and are thus presented in the paper at hand for the first time.

The paper is structured as followed: Section 2 informs about Swiss agglomerations and the need for information on their transport performances. Furthermore, it introduces both methods, the residential based as well as the territorial based approach. Section 3 provides details on the residential based analysis of the transport performance in the 50 Swiss agglomerations. Section 4 presents results from the territorial based analysis. All results must be understood as belonging to a case study. Calculations for both methods exclusively focus on car kilometres. In chapter 5 results from both methods are compared and discussed in relation to each other before conclusions are drawn in section 6.

2. Swiss agglomerations and their transport performance

Travel in agglomerations was chosen as the research objective for this case study as agglomerations are important administrative sub-areas in Switzerland. Their development is promoted by the Swiss government, whereby the amount of financial support depends on the evaluation of an agglomeration's strategy to face certain problems like e.g. challenges in traffic (ARE, 2010). They represent spots in which the population is densely clustered. Several aims of the Swiss governmental program are related to agglomerations. One indicator of the legislative period 2011 – 2015 is e.g. that the share of public and non-motorized transport on agglomerations' modal split does not decrease in terms of average daily kilometres travelled per person (Schweizerischer Bundesrat, 2012; BFS, 2012b). Furthermore, the "Raumkonzept Schweiz", a conceptual framework for a sustainable spatial development in Switzerland, suggests to increase population density within the agglomerations rather than accept urban sprawling, which means an unplanned settlement in open country (Schweizerischer Bundesrat *et al.*, 2012). In summary, agglomerations and their transport performance are of importance for political processes in Switzerland. However, detailed information on this performance is rare. Whilst there are figures based on the transport performance of agglomerations' residents,

complementary figures on the overall transportation performance in the agglomerations' territories are not available. A brief overview on the 50 Swiss agglomerations in terms of population, area, and the MCMT 2010 sample is provided in table 1.

Table 1: Overview on the 50 Swiss agglomerations

Name of agglomeration	N MCMT 2010	Population		Area	
		[abs]	[% CH]	[ha]	[% CH]
Aarau	882	88‘015	1.118	12'277	0.297
Amriswil-Romanshorn	238	26‘282	0.334	4'086	0.099
Arbon-Rorschach	865	59‘400	0.755	5'385	0.130
Baden-Brugg	917	117‘712	1.496	12'401	0.300
Basel	3‘240	497‘725	6.324	48'111	1.165
Bellinzona	630	50‘129	0.637	17'002	0.412
Bern	3‘082	353‘255	4.489	48'249	1.169
Biel	892	94‘104	1.196	9'365	0.227
Brig-Visp	261	33‘871	0.430	26'881	0.651
Buchs	224	22‘652	0.288	10'096	0.245
Bulle	550	27‘075	0.344	6'149	0.149
Burgdorf	367	28‘457	0.362	4'958	0.120
Chiasso-Mendrisio	604	48‘837	0.621	9'746	0.236
Chur	700	69‘962	0.889	31'181	0.755
Delémont	620	21‘351	0.271	8'744	0.212
Frauenfeld	247	29‘211	0.371	4'446	0.108
Fribourg	1‘362	104‘896	1.333	21'190	0.513
Genève	5‘094	526‘442	6.689	45'664	1.106
Grenchen	246	25‘370	0.322	4'560	0.110
Heerbrugg-Altstätten	603	53‘824	0.684	9'279	0.225
Interlaken	370	22‘660	0.288	6'865	0.166
Kreuzlingen	244	28‘790	0.366	3'115	0.075
La-Chaux-de-Fonds-Le Locle	777	47‘553	0.604	7'880	0.191
Lachen	403	37‘759	0.480	9'870	0.239
Lausanne	2‘296	336‘364	4.274	31'196	0.756
Lenzburg	491	29‘519	0.375	4'061	0.098
Locarno	580	60‘915	0.774	35'717	0.865
Lugano	588	133‘167	1.692	21'977	0.532
Luzern	1‘737	209‘796	2.666	19'756	0.479
Monthey-Aigle	281	38‘822	0.493	11'845	0.287
Neuchâtel	823	80‘789	1.027	12'348	0.299
Olten-Zofingen	885	110‘703	1.407	18'312	0.444
Rapperswil-Jona-Rüti	871	50‘449	0.641	5'581	0.135
Schaffhausen	681	66‘247	0.842	12'412	0.301
Schwyz	288	26‘016	0.331	7'852	0.190
Sierre-Montana	251	37‘097	0.471	13'293	0.322
Sion	614	61‘045	0.776	26'216	0.635
Solothurn	917	75‘982	0.965	10'863	0.263
St. Gallen	1‘084	150‘229	1.909	17'474	0.423
St. Moritz	243	14‘835	0.188	50'206	1.216
Stans	478	30‘514	0.388	9'403	0.228
Thun	886	95‘322	1.211	8'719	0.211
Vevey-Montreux	797	91‘977	1.169	20'955	0.508
Wetzikon - Pfäffikon	744	51‘409	0.653	9'376	0.227
Wil	891	70‘095	0.891	10'630	0.257
Winterthur	943	139‘877	1.777	15'105	0.366
Wohlen	521	22‘916	0.291	2'898	0.070
Yverdon-les-Bains	332	33‘562	0.426	3'591	0.087
Zug	937	108‘704	1.381	17'961	0.435
Zürich	7‘662	1‘188‘566	15.102	108'583	2.630
All agglomerations		5‘730‘249	72.811	873'831	21.166

2.1 Residential based analysis

When talking about the agglomeration specific modal split, as mentioned in the definition of the aims of the Schweizer Bundesrat's legislative period 2011 – 2015, figures are calculated residential based. This means that all distances reported by respondents from the study area, here all Swiss agglomerations, are considered in the analysis. So, the modal split of Swiss agglomerations is based on all respondents in the MCMT who live in an agglomeration and their trips as reported for the reference day. The average distance per person from the study area multiplied by the number of residents from this area multiplied by 365 days results in the annual transport performance of this area.

Formally, the residential based approach can be summarised as:

$$\hat{c}_{inhab} = N_{P_{inhab}} N_J \sum_{p \in S_{P_{inhab}}} w'_p \, c_{p,j_p}$$

$$\text{whereby } w'_p = \frac{w_p}{\sum_{q \in S_{P_{inhab}}} w_q}$$

with

$\widehat{\hat{c}_{inhab}}$ = Annually distance [km] travelled by the residential population of the study area

c_{p,j_p} = Distance of person p on day j

w_p, w_q = Statistical weight of persons p and q

$S_{P_{inhab}}$ = Sample of persons from MCMT that live within the study area

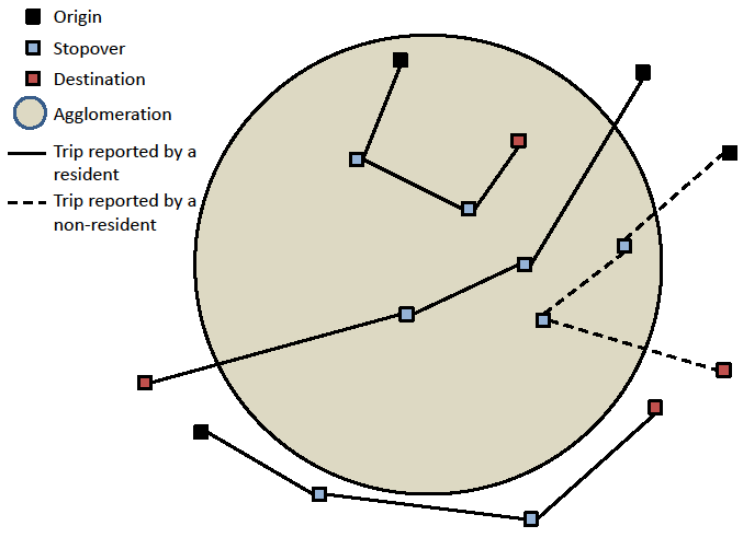
$N_{P_{inhab}}$ = Residential population of the study area

N_J = Number of days per year

Resulting from this calculation are figures which describe the travel behaviour of the residents of a specific area, not the actual transport performance within this area. Figure 1 illustrates the method. The study area, in our example a Swiss agglomeration, is represented by a circle. Three residents from the study area and one non-resident reported their trips for the reference day in a survey (e.g. the MCMT 2010). One resident started in the study area and performed

all trips within this area. A second resident started outside the area, crossed it in the course of the day with the final destination of the tour lying outside the study area. A third resident does not report any trips within but some trips outside this area for the reference day. Reported distances of all three persons are considered in the calculation of residential based transport figures, independently from their location of performance. In contrast, all trips reported by non-residents are not considered at all, even if they are performed within the study area. As trip selection is based on respondents' home location there is no need for routing information in this approach.

Figure 1: Illustration of residential based travel performances (calculations only include MCMT-respondents that are residents of the study area).



2.2 Territorial based analysis

Territorial based figures on transport performance focus on the area of interest and all trips reported for this area. So, this method does not include information on personal characteristics like home locations but needs routing information to differentiate between trip segments

within and outside the study area. The approach results in the number of kilometres that were reported as having been performed within the study area by the whole survey population (which is in case of the MCMT a sample of the Swiss residential population). This number of kilometres multiplied with the whole population of Switzerland and the number of days in a year results in the number of kilometres performed within the study area. Employing the whole survey population is essential for the territorial based approach as each respondent in the MCMT could potentially have performed a trip or at least a trip segment in an agglomeration for the reference day.

Formally, the territorial based approach can be summarised as:

$$\hat{c}_{within} = N_P N_J \sum_{p \in S_P} w'_p \, c_{p,j_p}$$

$$\text{whereby } w'_p = \frac{w_p}{\sum_{q \in S_P} w_q}$$

with

$\hat{c}_{within}$ = Annually distance [km] travelled within the study area by Swiss residents

c_{p,j_p} = Distance of person p on day j within the study area

w_p, w_q = Statistical weight of persons p and q

S_P = Sample of persons from MCMT

N_P = Residential population of Switzerland

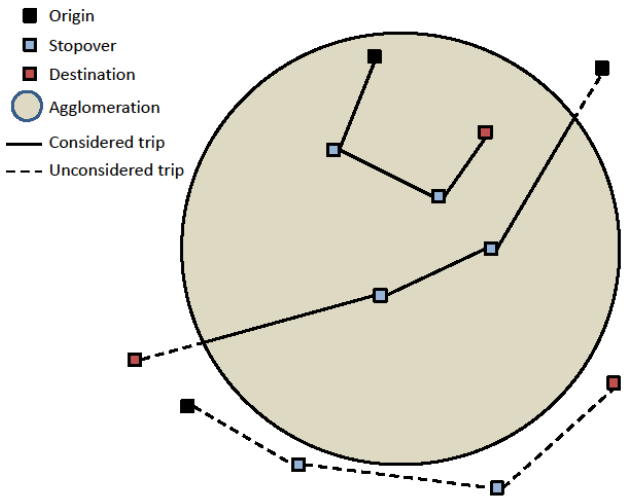
N_J = Number of days per year

An illustration of the method is provided in figure 2, which includes a study area (in our example any Swiss agglomeration, represented by a circle) and reported trips from three respondents of a survey study (the MCMT). The territorial based approach employs all trip segments that have been performed within the study area, whereby a trip segment is a short-distance part of a trip that can be identified in the routing information (see section 2.3). Personal characteristics like location of respondents' dwellings do not influence the trip selection. What

exclusively matters is where the reported trips are performed. All trips within the study area are considered, all trips performed outside these boundaries remain unconsidered.

In the illustration one person reported a whole tour within the study area. Accordingly, all three trips are considered in the analysis. The second person starts a tour outside the study area, crosses it with two activities being performed within the study area and leaves it again finally. In this case all trip segments within the study area are considered. The same would be true in case of a transit trip (a trip crossing the study area without any activity in between) and in case of origin and destination trips that start or end in the study area. Finally, if a person exclusively reports trips from outside the study area, none of these trips are employed in the calculation.

Figure 2: Illustration of territorial based travel performances (calculations include all MCMT-respondents independently from where they live).



2.3 General remarks on calculating travel performances

Analysis for both approaches, whether calculations are residential or territorial based, are limited to car kilometres. Therefore, only trips (or trip segments), which the MCMT-

respondents performed as car-drivers are considered. This selection affects both the residential based and the territorial based equations: The population totals employed must consist of the number of residents over 18 years (in case of the residential based approach the number of agglomerations' residents, in terms of the territorial based approach the number of Swiss residents). Only those respondents could potentially have reported car trips as drivers. Population totals for both the whole country and the agglomerations were calculated using data from the Swiss census 2010 (BFS, 2011).

Territorial based figures have been calculated exclusively throughout Switzerland in the past. This was possible as the MCMT includes geo-referenced trip origins and destinations since 2005. In case a trip started or ended abroad, the whole trip was excluded from the calculation (for the national transport performance in Switzerland see BFS, 2012c). However, the territorial based approach has never been employed for calculations on tranport performances within Swiss sub-territories before, as there were no routing information available on a national scale before 2010 (for details on the routing tools see Ohnmacht *et al.*, 2012). This situation changed with the MCMT 2010 which includes routing information and allows territorial based calculations. In order to calculate trip distances within the study area as precisely as possible, routing information on road segments was employed. All segments that are ascribed to a study area (a predefined Swiss agglomeration) are considered in the analysis.[1] In case of border crossing road segments, some are assigned to the study area whilst others are not. Resulting errors in trip length can be assumed to be normally distributed with an expected value of zero. This assumption is important as it suggests resulting figures being valid and unbiased.

[1] Routing distances in the MCMT 2010 are based on the TeleAtlas street network (TomTom MultiNet, 2013).

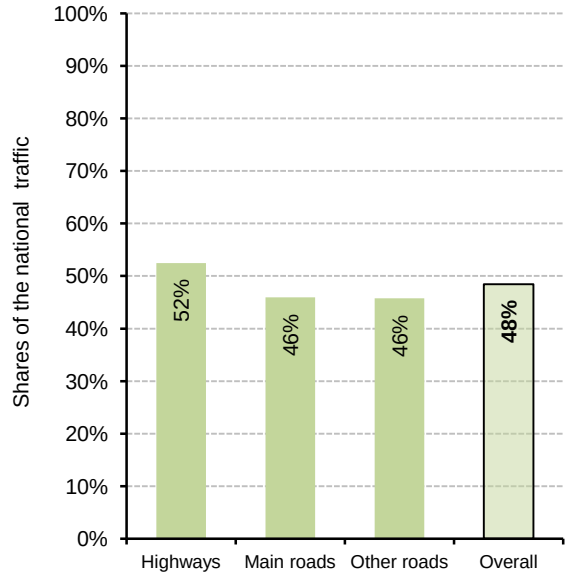
3. Descriptive statistics: Residential based agglomeration traffic

This chapter presents the results obtained with the residential based analysis of the agglomeration traffic. It focuses on the share of the national car kilometre performance by agglomeration residents and on the road classes used.

3.1 Shares of national traffic performed by agglomeration residents

Residents of the 50 Swiss agglomerations performed over 22'500 Mio. kilometres by car in 2010, accounting for almost half of the national car kilometres (Fig. 3). Thus, agglomeration residents, who represent around 73% of the Swiss population, perform less car kilometres than people living outside agglomerations on average. This can be explained by the high supply of public transport within the agglomerations, which decreases the importance of private cars. Particularly on highways, agglomeration residents show an increased traffic performance with a share of 52% in the national traffic. On all other road classes, they account for 46% of the national traffic.

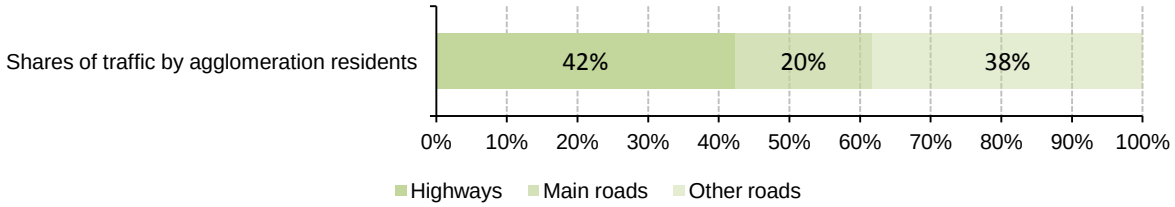
Figure 3: Shares of national traffic performed by residents of Swiss agglomerations on different road classes (only car kilometres within Switzerland).



3.2 Road classes used by agglomeration residents

Agglomeration residents primarily use highways and small roads. Over 42% of all car kilometres travelled by agglomeration residents were performed on highways and around 38% on small roads (Fig. 4). Only 20% of all car kilometres travelled by agglomeration residents are performed on main roads. The good connection of agglomerations to the road network possibly explains the low importance of main roads. For short distances (e.g. within the agglomeration or city), small roads, labelled as other roads, are used. For long distances, main roads are not large enough to compete with highways, which are thus the preferred road class for this type of trips.

Figure 4: Road classes used by agglomeration residents (only car kilometres within Switzerland).



4. Descriptive statistics: Territorial based agglomeration traffic

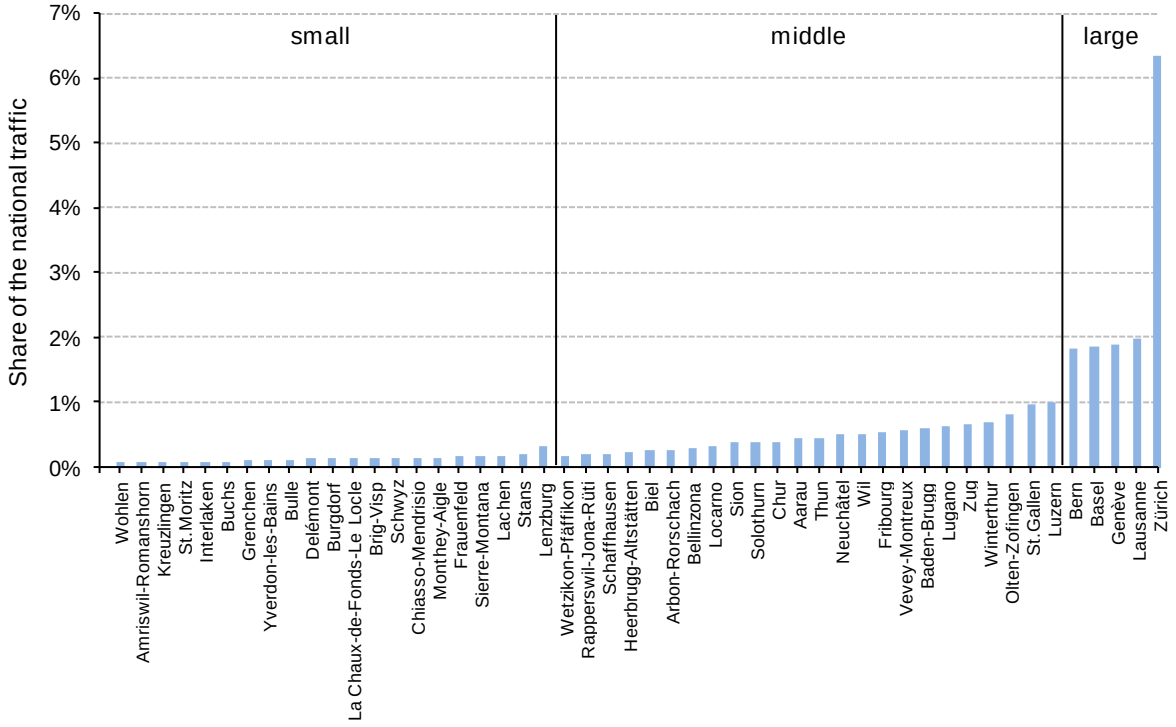
The following sections present results on agglomeration traffic according to territorial based calculations. The focus is set on the shares of the nationally performed car kilometres on agglomeration territories and on the distribution of the inner-agglomeration traffic on different road classes. Furthermore, results on the share of agglomeration traffic performed as transit traffic are presented.

4.1 Share of national traffic within agglomerations

In total, over 13’000 Mio. car kilometres are travelled within the 50 Swiss agglomerations. This represents more than 28% of the nationally performed car kilometres in 2010. This figure

is not surprising, as the agglomerations cover more than a fifth of Switzerland's total area and represent hot spots in terms of residential population and employment.

Figure 5: Shares of national traffic performed within the Swiss agglomerations (only car kilometres within Switzerland).

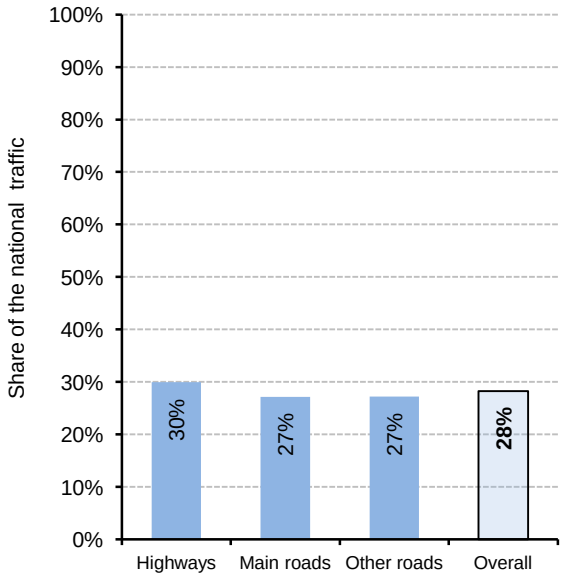


However, there are large differences between the agglomerations. Figure 5 provides shares of car kilometres in the national travel performance for each agglomeration. It clearly shows the importance of large agglomerations (at least 250'000 residents, ARE, 2009) in general and of Zürich especially. The four large agglomerations Bern, Basel, Genève, and Lausanne represent a share of almost 2% of the nationally performed car kilometres each. Noteworthy is the fact that Lausanne represents the highest share among this group whilst it has the lowest number of residents, working places, and the smallest area in comparison to the other three large agglomerations (agglomeration area needs to be considered carefully, as it does not necessarily represent the activity or importance of an agglomeration). Bern (lowest share among the

group) has the largest area of this group, but a smaller population and less working places than Basel and Genève. These findings are consistent with other results of the MCMT highlighting the high importance of private cars in Lausanne and the importance of public transport in Bern. The agglomeration of Zürich clearly represents a separate class, being responsible for over 6% of the national car kilometres. This result was expected as Zürich is the by far largest agglomeration in terms of population and working places and area.

Focussing on middle (50'000 to 249'999 residents, ARE, 2009) and small (20'000 to 49'999 residents, ARE, 2009) agglomerations shows the majority representing minor shares of less than 0.4% in the national car kilometres. Aarau is the first agglomeration with a share above 0.4% in the national car kilometres. This share increases up to 0.7% in Winterthur. The agglomeration of Olten-Zofingen represents 0.8% of the national traffic, followed by St.Gallen and Luzern with nearly 1% each.

Figure 6: Shares of national traffic performed within Swiss agglomerations on different road classes (only car kilometres within Switzerland).



Focussing on the inner-agglomeration traffic shows it being nearly equally distributed between road classes (Fig. 6). Only highways are slightly over-represented. Almost 30% of the national car kilometres travelled on highways are performed within the agglomerations. On main roads and other roads, the share of car kilometres travelled within agglomerations is around 27%.

4.2 Transit traffic

The territorial based approach allows to distinguish between different kinds of traffic relations. Of particular interest is the share of transit traffic within agglomerations. Transit traffic describes car trips that start and end outside an agglomaration but cross its territory in between.

Figure 7: Shares of traffic within Swiss agglomerations performed as transit (only car kilometres within Switzerland).

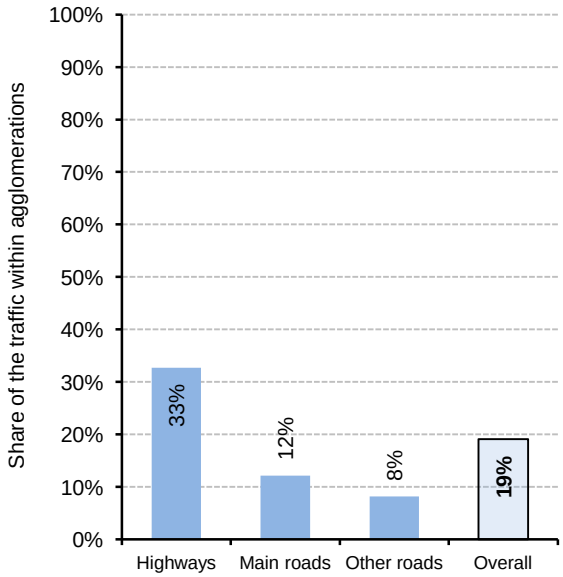
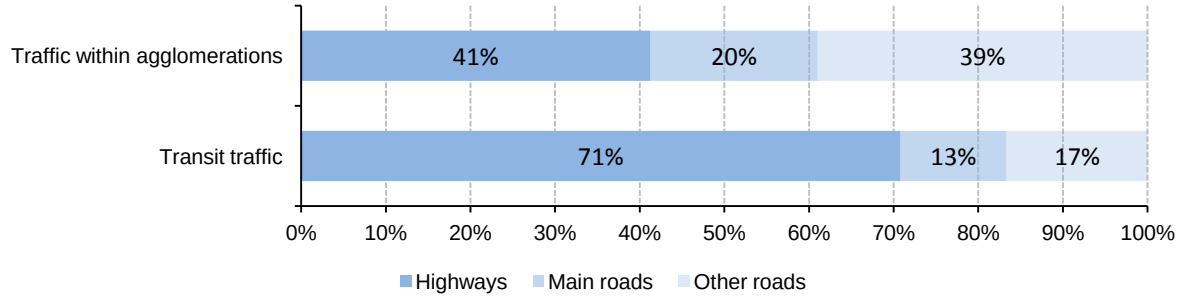


Figure 7 shows the share of transit traffic in the territorial based agglomeration traffic, distinguishing between the three road classes. Over all road classes, more than 19% of the traffic within agglomerations is caused by transit traffic on average. However, there are intersting differences between the road classes: While only 8% of the traffic on small roads is due to transit, its share is 33% on highways. On main roads within agglomerations, 12% of the traffic is due to transit.

The importance of highways to transit traffic can also be seen on the distribution of transit traffic between the road classes. Whereas 41% of all traffic within agglomerations is located on highways, transit takes place to 71% on this road class (Fig. 8). As well regarding the overall agglomeration traffic as the transit traffic, main roads only account for a minor part of the traffic. In contrast to the overall agglomeration traffic, from which 39% is performed on small roads, this share is only 17% when considering transit traffic exclusively.

Figure 8: Road classes used for agglomeration traffic and for transit (only car kilometres within Switzerland).



These results support the hypothesis formulated in section 3.2. Small roads are used to travel within the agglomeration and highways to travel between agglomerations. Whereas a substantial part of the inner-agglomeration traffic is performed on small roads, they are used marginally for transit, which is mainly located on highways.

Among the 5 large agglomerations, only Bern has a share of transit traffic which is approxi-

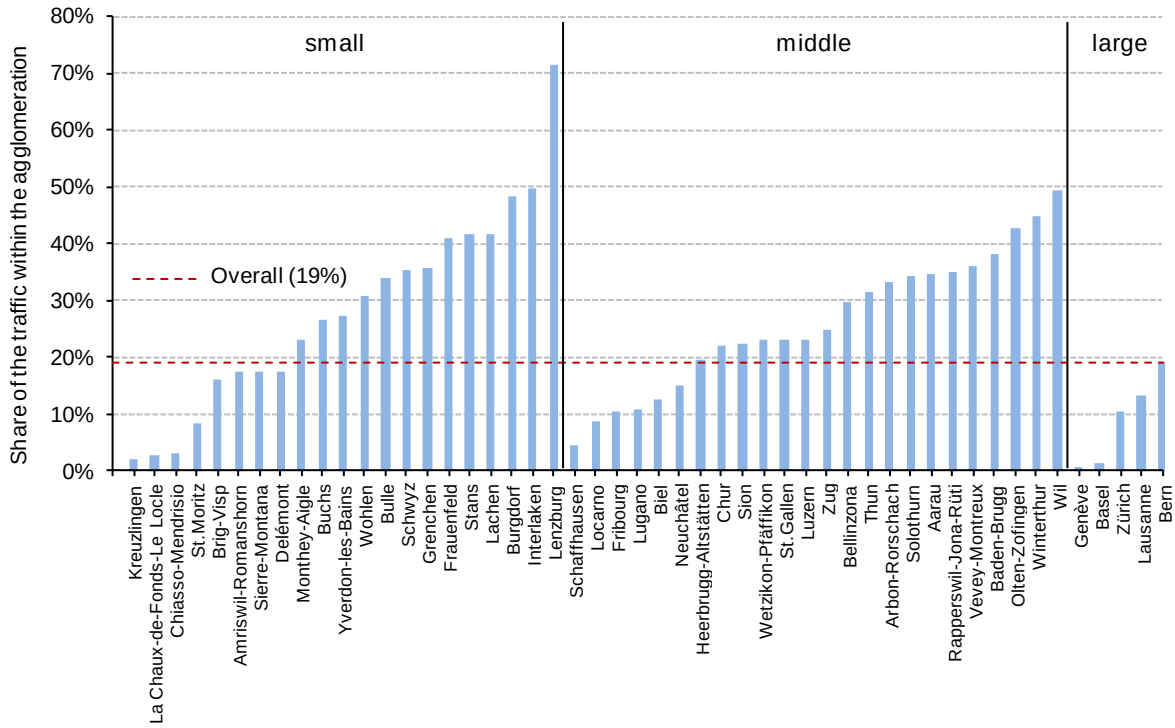
mately equal to the national average (Fig. 9). The other four large agglomerations show shares of transit traffic below average. This is possibly due to large agglomerations being the origin or the destination of trips rather than only transited due to their large population and attractiveness.

In general, it has to be notified that the six agglomerations with the lowest shares of transit traffic (Genève, Basel, Kreuzlingen, La-Chaux-de-Fonds – Le Locle, Chiasso-Mednrisio and Schaffhausen) are all located at the country's border. Transit in these agglomerations is more likely to have its origin and/or destination outside Switzerland. As trips travelled abroad are not considered in this study, this kind of transit traffic is not taken into consideration. This bias clearly decreases the share of transit traffic in border agglomerations.

In 9 agglomerations (Frauenfeld, Stans, Lachen, Olten-Zofingen, Winterthur, Burgdorf, Wil, Interlaken, Lenzburg), transit accounts for over 40% of the overall agglomeration traffic. Winterthur is by far the largest of these 9 agglomerations. Its high transit share can possibly be explained by its vicinity to Zürich. The agglomeration of Winterthur might be crossed on the way to and from Zürich.

Lenzburg is clearly the agglomeration most affected by transit traffic. Over 70% of the territorial based agglomeration traffic is due to transit. The agglomeration of Lenzburg is situated close to Zürich and is crossed by Switzerland's most important east-west highway. Unlike Baden-Brugg (next to Lenzburg) or Winterthur, Lenzburg is not adjacent to Zürich. This potentially increases transit traffic, as trips with origin in any agglomeration and destination in an adjacent agglomeration the other are not counted as transit traffic.

Figure 9: Shares of transit traffic in the overall agglomerations traffic (only car kilometres within Switzerland).



In general terms, the amount of transit traffic decreases with increasing agglomeration size. Large agglomerations attract people whereas small agglomerations are more often crossed to reach another destination.

5. Combined analysis

The combination of residential and territorial based calculations allows new insights into mobility behaviour. It provides e.g. figures on distances performed within and outside the agglomeration's territory by its residents or shares of agglomeration traffic performed by people living within or outside an agglomeration.

5.1 Residents' car kilometres within their own agglomeration

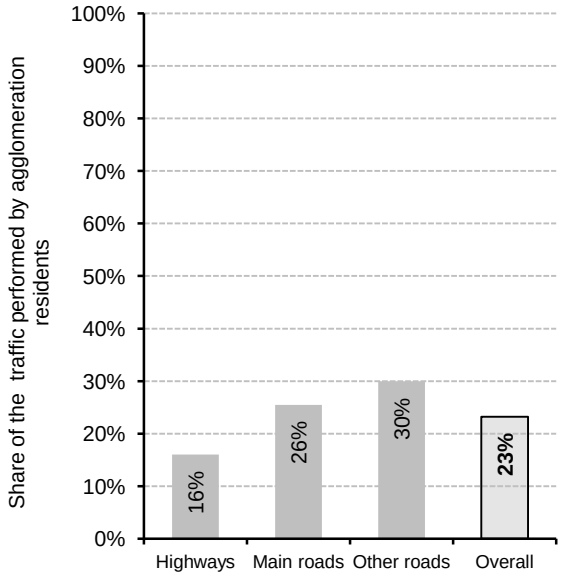
The share of car kilometres agglomeration residents perform within their own agglomeration is an indication for the attractiveness of the agglomeration for its own residents. In addition, it

gives a hint on the importance of public transport for the inner-agglomeration traffic.

On average, the residents of all Swiss agglomerations travel 23% of their total distance as car drivers within their respective agglomeration. Consequently, 77% of all car kilometres travelled by agglomeration residents are performed outside their residential agglomeration.

The share of traffic performed within the residential agglomeration increases with decreasing road size (Fig. 10). Only 16% of the residential based traffic on highways also take place within the performer's respective residential agglomeration. The share increases to 26% for main roads and to 30% for small roads. These results support the hypothesis that highways are primarily used for long distance trips between agglomerations and that small roads are preferentially used for internal trips within the agglomerations.

Figure 10: Shares of residential based traffic performed within the residential agglomeration (only car kilometres within Switzerland).



In general terms, the proportion of car kilometres travelled within the residential agglomeration increases with the size of an agglomeration. Figure 11 shows the shares of residential based traffic performed within the residential agglomeration. Most small and middle agglom-

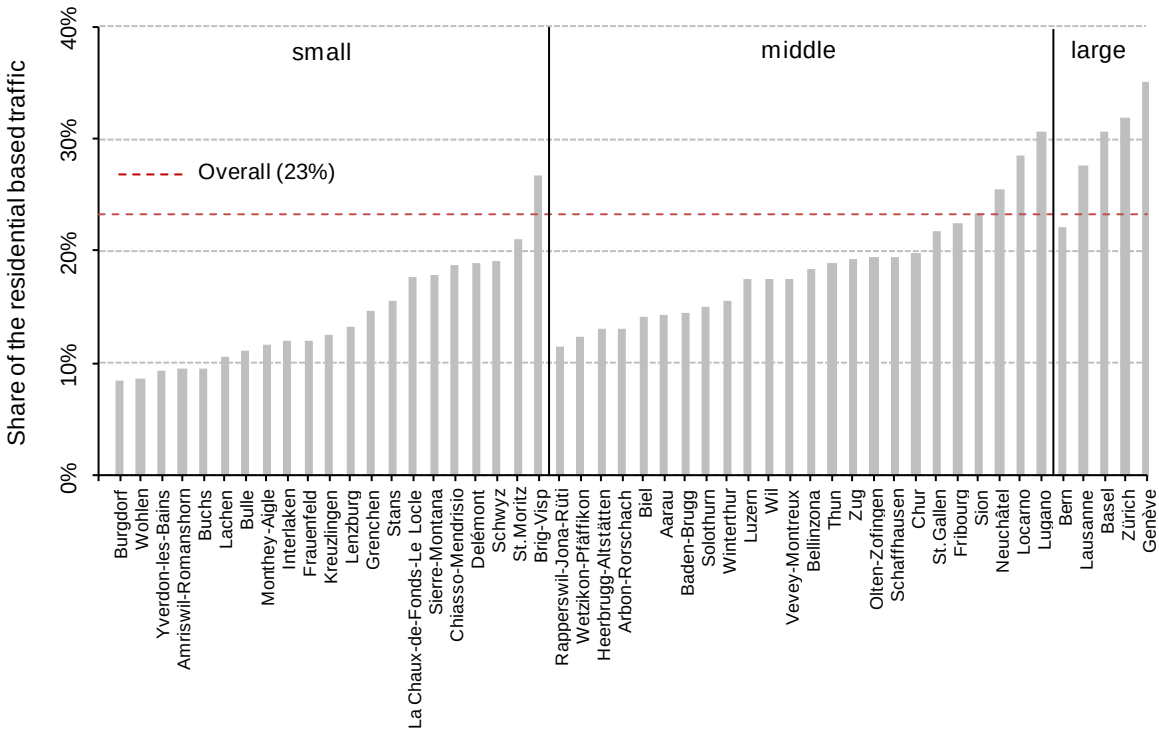
erations show lower shares than average. These agglomerations are often located in the periphery of larger agglomerations such as e.g. Burgdorf, Wohlen, Lachen, Rapperswil-Jona-Rüti, Wetzikon-Pfäffikon (periphery of Zürich). Several small and middle agglomerations however also show high shares of residential based traffic performed in the residential agglomeration. Middle agglomerations like Lugano, Locarno, Neuchâtel and Sion, but also the small agglomeration of Brig-Visp have share values above the national average. These agglomerations are geographically isolated with no large agglomeration nearby, reducing the probability that their residents perform trips to another agglomeration.

Earlier analysis on the MCMT 2010 stated that public transport is under-represented and private motorised transport over-represented in the Italian speaking part of Switzerland (BFS, 2012a). The low importance of public transport in Lugano and Locarno partly explains the high shares of residential based traffic within these agglomerations. Their residents are more likely to use private motorised vehicles even to stay within these agglomerations. In addition, Lugano represents an important regional centre and is in this sense similar to a large agglomeration.

In the group of large agglomerations, Bern clearly shows the lowest proportion of residential based traffic within its territory. In contrast to Lugano, Bern is characterised by a high proportion of public transport (BFS, 2012a). Trips within the agglomeration of Bern are often performed using public transport, decreasing the share of private motorised transport performed by residents within the agglomeration.

Another important factor results from the agglomerations' territory. Lausanne clearly covers the smallest area. Consequently, the probability that traffic takes place within the agglomeration is lowered and Lausanne showing a lower share than the three remaining large agglomerations.

Figure 11: Shares of traffic performed by agglomeration residents within their residential agglomeration (only car kilometres within Switzerland).

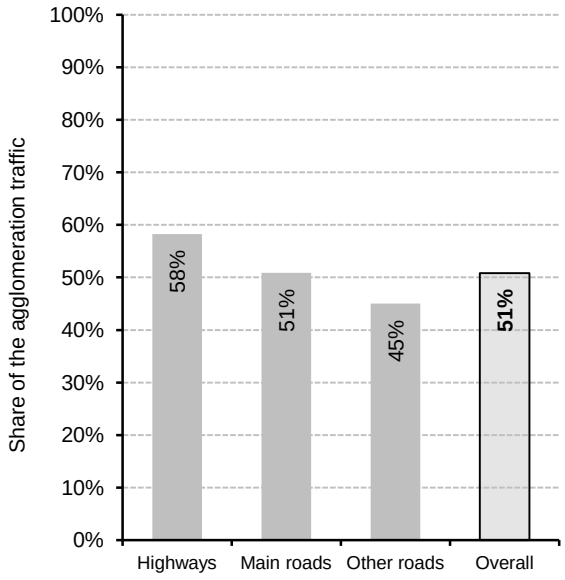


5.2 Territorial based traffic performed by non-residents (without transit)

The share of territorial based traffic without transit caused by people coming into the agglomeration from outside indicates the attractiveness of an agglomeration for its surroundings (relatively to its size). On average, 51% of the territorial based agglomeration traffic is caused by people living outside the agglomeration they travel in.

This “incoming traffic” is mostly performed on large roads (Fig. 12). Accordingly, 58% of the car kilometres on highways within agglomerations are performed by people driving into the agglomerations (and out again). “Incoming traffic” accounts for 51% of the territorial based agglomeration traffic on main roads and for 45% on small roads.

Figure 12: Shares of traffic within Swiss agglomerations performed by non-residents (without transit, only car kilometres within Switzerland).

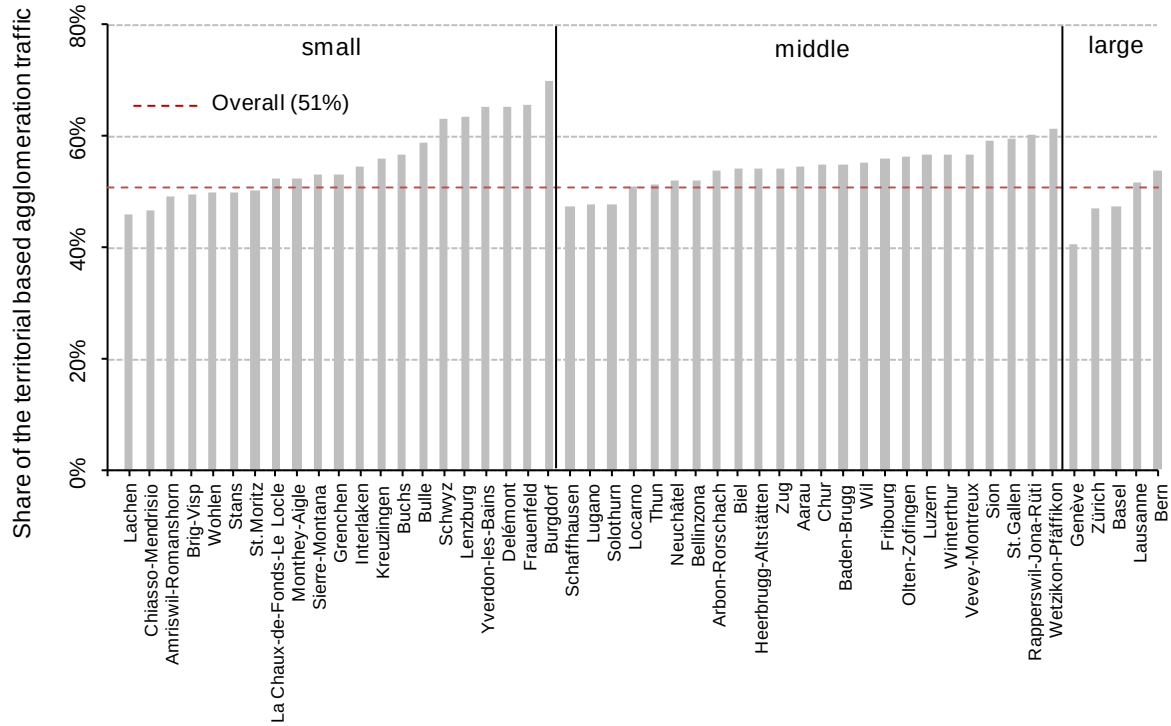


Shares of territorial based agglomeration traffic performed by non-residents are shown in figure 13. The share of "incoming traffic" generally decreases with increasing agglomeration size. Whereas several small agglomerations show shares above 60%, only two middle and no large agglomerations do. Small agglomerations thus seem to have a relatively high importance for their surroundings. Having low numbers of residents, they attract a high proportion of non-residents. It is however also possible that small agglomerations show higher shares because they have a lower public transport supply than large agglomerations. People travelling into the agglomeration preferentially use cars in the case of small agglomerations and public transport in the case of large agglomerations. The low shares of the large agglomerations also have to be put into perspective, since they represent high absolute car kilometres and large area, including important parts of the regional traffic.

The distribution range gets smaller with increasing agglomeration size. Only exception is Genève, which shows the lowest share of all agglomerations. Genève is however surrounded by settlements in French territory from where many people commute to the city. As only

Swiss residents are considered, it is not surprising to see Genève under-represented in this statistic. Similar observations can be made for the agglomerations of Chiasso-Mendrisio and Schaffhausen. Basel seems to attract more people from Switzerland than Genève although having a similar situation on the Swiss border.

Figure 13: Shares of traffic within Swiss agglomerations performed by externals (without transit, only car kilometres within Switzerland).



6. Conclusions

The routing system introduced in the MCMT 2010 allows to analyse mobility behaviour as well from a residential based as from a territorial based perspective. The residential based analysis considers all trips performed by an agglomeration's residents, whether they are performed in- or outside the agglomeration area. Any trips performed by people living outside an agglomeration are not considered, even if they are performed within an agglomeration. The

residential based approach thus yields the travel performance of agglomeration residents in Switzerland.

Territorial based calculations in contrast include all trips of the Swiss residential population performed within an agglomeration, independently from the location of an actor's domicile. This approach does not consider any trips outside an agglomeration's area, even if it is performed by an agglomeration's resident. Consequently, the territorial based method provides information on the travel performance of the Swiss population within an agglomeration's territory.

The two methods are complementary when approaching agglomeration traffic. Combining them allows to gain information about the attractiveness of agglomerations to their residents and to non-residents, the purpose of travelling in an agglomeration (e.g. transit) as well as agglomeration-related modal split.

The results obtained in this case study show that agglomeration residents perform only a low share of the overall national car kilometres in comparison to the proportion of the population they represent. This can be attributed to the comparatively high public transport supply within agglomerations.

In contrast, the share in the national car kilometres performed within agglomerations is higher than the share of agglomerations in the country's area. Despite the high supply of public transport, the agglomerations can be recognised as population and employment poles that attract people for one reason or another.

The distribution of the traffic performance on three road classes suggests that small roads are used for short distances within agglomerations, main roads for travelling to agglomerations from the close surroundings and highways for long distance trips between agglomerations. Consequently, the large majority of transit traffic within agglomerations takes place on highways.

Finally, there are hints that agglomerations of all sizes are attractive for their surroundings. Whilst this paper introduced the territorial based approach to focus on car kilometres exclusively, it is part of future work to expand this focus and apply it to all traffic modes. This will allow to calculate a territorial based modal split for every agglomeration.

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