Modelling foreign tourists in Switzerland

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Abstract

The agent-based transport model SIMBA MOBi is applied by Swiss Federal Railways to plan future rail infrastructure, timetables, and service concepts. It reacts to changes in demographics (ageing, migration, household location), transport supply, and policy. We present an extension to model tourist behaviour. It should (1) react to a change in tourist accommodation (e.g., a new hotel), in tourist attractions (e.g., a new museum) and in the tourist population (e.g., a change in the countries of origin of tourists in Switzerland) and (2) enable a more accurate analysis of foreign tourists in train stations.

The model is built in three steps. First, we generate agents, each with a country of origin and a tourist accommodation (hotels and supplementary accommodations such as holiday homes, collective accommodation and campsites). This part is based on data from the Swiss Federal Statistical Office (overnight stays in 2019) and Openstreetmap (location of accommodation as of today). Second, we generate a main transport mode for each agent. The estimation of the choice model is based on data from the Tourism Monitoring Switzerland 2017. Third, we generate activity plans for the agents and define a destination choice model.

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Keywords

Switzerland, tourists, agent-based model, MATSim, SIMBA, SIMBA MOBi, SBB, Swiss Railways, mode choice, main transport mode, tourist accommodation

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1 Introduction

In its Transport Outlook 2050 (`www.are.admin.ch/transport-outlook`), the Swiss government predicts that people will be commuting to work less frequently in 2050, while travelling more in their leisure time. The planning of passenger transport services must take this increase of leisure trips into account. Transport planning tools must be able to properly represent this increase in order to best prepare the timetables of the future and to design a demand-driven service for customers.

The agent-based transport model SIMBA MOBi is one of the transport planning tools used at the Swiss Federal Railways (SBB CFF FFS). It is applied at SBB to plan future rail infrastructure, timetables, and service concepts. It reacts to changes in demographics (ageing, migration, household location), transport supply, and policy.

Leisure trips taken by the Swiss resident population are already integrated into SIMBA MOBi based on the detailed data from the Mobility and Transport Microcensus (MTMC). Trips by non-Swiss tourists represent about 2% of total rail demand in Switzerland. These trips are integrated into SIMBA MOBi, but, in contrast to leisure trips made by the Swiss resident population, those made by foreign tourists are almost completely insensitive to changes in demographics, transport supply, or policy. Also, in their current state, these agents only react to a change in the offer (e.g., a new timetable) by taking another route. There is no modal shift and in general no change in destination choice, which makes it difficult to interpret simulation results. The current model cannot be used to predict future scenario states without making many exogenous hypotheses.

In this paper, we present an extension of SIMBA MOBi: the mobility of foreign tourists traveling within Switzerland will be integrated as behavioural models. The goals of this extension are:

- to react to changes in
  - tourist accommodations (e.g., new hotels),
  - tourist attractions (e.g., new museums), and
  - the tourist population (e.g., a change in the countries of origin of tourists traveling to Switzerland), and,
- to enable a more accurate analysis of foreign tourists in train stations.

In this article, we focus on trips with overnight stays made by foreign tourists in Switzerland. Single-day trips are not considered in the model. The arrival and departure trips, at the

beginning and end of the tourists' stay in Switzerland, are already modelled in SIMBA MOBi in different submodels of exogenous demand:

- Border crossing traffic, both for regional and long-distance rail, and on the road;
- Traffic generated by airports, both by rail and on the road.

The goal here is to model tourist mobility within Switzerland, as opposed to border-crossing trips made when entering and leaving the country.

2 Data sources

In this section, we present the sources used in our extension of the agent-based transport model SIMBA MOBi.

Data on foreign tourists in Switzerland is less rich and detailed than that available for the Swiss resident population.

To avoid the effect of the Covid-19 pandemic, we build a model based on the year 2019.

One very important piece of information about foreign tourists in Switzerland is missing: we don't know the average daily distance traveled during their stay.

It might be possible to know the number of tickets sold on the SBB website, sbb.ch, by persons with a billing address abroad. These data have not been used in our model. However, we plan to use the sales data of the Swiss Travel Pass (see Section 2.4 below).

2.1 Tourist accommodation statistics 2019

The Swiss Federal Statistical Office (FSO) conducts two surveys about tourist accommodation:

- the tourist accommodation statistics (HESTA)
- the supplementary accommodation statistics (PASTA)

Both surveys are conducted at the national level. The HESTA is exhaustive and compulsory. Between 5000 and 6000 hotels are contacted each month, and the key variables recorded are arrivals, overnight stays, and tourists' country of residence. The FSO does not make the information available at the individual hotel level, however. Data is aggregated by commune for communes with three or more hotels; otherwise, only aggregates by canton are provided.

The PASTA collects data on holiday homes (Table 1) and collective accommodation (Table 2) based on a sample survey.

Table 1: Number of overnight stays in holiday homes per day on average in 2019, rounded, by major region.

Major region	**Number of overnight stays**
Lake Geneva region	3740
Espace Mittelland	1578
North-West Switzerland	54
Zurich region	60
Eastern Switzerland	1716
Central Switzerland	600
Ticino	301
Total	8049

Table 2: Number of overnight stays in collective accommodations per day on average in 2019, rounded, by major region.

Major region	**Number of overnight stays**
Lake Geneva region	1104
Espace Mittelland	958
North-West Switzerland	12
Zurich region	20
Eastern Switzerland	551
Central Switzerland	272
Ticino	73
Total	2990

Campsites are a special case: they are part of the HESTA (and are therefore exhaustively collected). They are, however, classified as "supplementary accommodation" on the FSO website, and their most detailed aggregation is by "tourist region". Tourist regions are unfortunately only defined in imprecise words (e.g. the region "Eastern Switzerland" is defined as, among others, "the Canton of Schaffhausen (without part of the Schaffhausen

district)"; which part exactly is not known). Attempts to obtain geodata for these regions have failed. We consequently use the data grouped by "major regions" (Table 3).

Table 3: Number of overnight stays in campsites per day on average in 2019, rounded, by major region.

Major region	**Number of overnight stays**
Lake Geneva region	776
Espace Mittelland	845
North-West Switzerland	51
Zurich region	191
Eastern Switzerland	518
Central Switzerland	379
Ticino	559
Total	3319

In this study, we use data from both the 2019 HESTA and the 2019 PASTA.

2.2 Tourism Monitor Switzerland 2017

The Tourism Monitor Switzerland (TMS) collects data about tourists, both from Switzerland and abroad, at the Swiss national level, focusing on overnight stays and leisure trips. It is run by Switzerland Tourism. The last available data were collected in 2017. A survey is being conducted in 2023, and its results will be published around September 2024.

The sample contains 21'535 tourists staying overnight at an accommodation located in Switzerland. The data were collected between November 2016 and October 2017 and contains information about the "source market" (i.e., country of origin of the tourist), the destination (tourism zone and region, etc.), type of travel (season, accommodation, hotel classification, touring (is the stay in Switzerland part of a tour in either Switzerland or Europe), means of transportation within Switzerland, travel package, group size) and personal information, in particular socio-demographic characteristics and information about travelling with children.

2.3 Passenger survey

Specialised SBB employees regularly collect data in trains during trips. The dataset contains information about the ticket type, as well as the train stations of origin and destination. A calibration of the count data is performed. We do not know if passengers are foreign tourists or not. It is, however, possible to filter by ticket type and to know count data for tickets available only to foreigners, such as the Swiss Travel Pass, Interrail, or Eurail.

2.4 Sales data from the Swiss Travel System

It is possible to know how many Swiss Travel Passes have been sold in any given year, with information about the market of origin.

2.5 Location and characteristics of tourist accommodation from Openstreetmap

We have downloaded data about tourist accommodation from Openstreetmap.org (OSM) in 2023. Since we use 2019 as our reference year, we remove tourist accommodations that opened later than 2019, whenever this information is available.

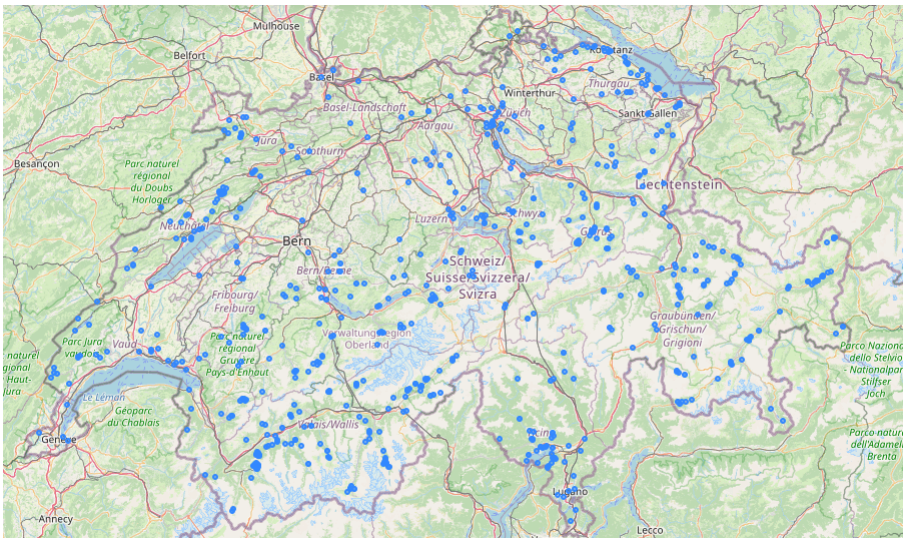
2.5.1 Hotels

A list of 4'957 hotels located in Switzerland was downloaded from OSM. In comparison, the Federal Office for Statistics identified 4646 hotels in Switzerland in 2019. The categories used on Openstreetmap to select hotels were `tourism=hotel` (3901 cases), `tourism=guest_house` (1012 cases) and `tourism=motel` (44 cases). The downloaded data contains, among others, the exact geolocation (x-y coordinates), the commune and the address of the hotel, as well as, in some cases, the number of stars (728 cases), beds (132 cases) or rooms (420 cases).

2.5.2 Holiday homes

Similarly, 895 holiday homes were downloaded from Openstreetmap using the tags `tourism=apartment` (235 cases) and `tourism=chalet` (660 cases). The dataset contains the coordinates and, for some cases, the number of beds (18 cases), the number of rooms (29 cases), the number of apartments (14 cases) and the capacity (attributes `capacity` - 12 cases - and `capacity:persons` - 2 cases). The holidays homes are generally evenly distributed throughout Switzerland (Figure 1).

Figure 1: Holiday homes in Switzerland according to Openstreetmap



This number of holiday homes listed on Openstreetmap is underestimated. The Federal Office for Statistics asserts that 29'438 holiday homes were used commercially in Switzerland in 2021 (Swiss Federal Statistical Office (FSO), 2023). Unfortunately, the comprehensive list of holiday homes was not made available to the authors. In the case of a local case study, we might improve the model by collecting more data, by e.g. contacting the commune. This would, however, generate a large amount of manual work.

We observe that holiday homes are relatively numerous in typical tourist areas of the Alps (see the example of Verbier, Figure 2) in comparison to the number of holiday homes in cities (see the example of the Bern area, with almost no holiday homes, Figure 3). Openstreetmap most probably underestimates the number of holiday homes in urban areas.

Figure 2: Holiday homes in Verbier according to Openstreetmap

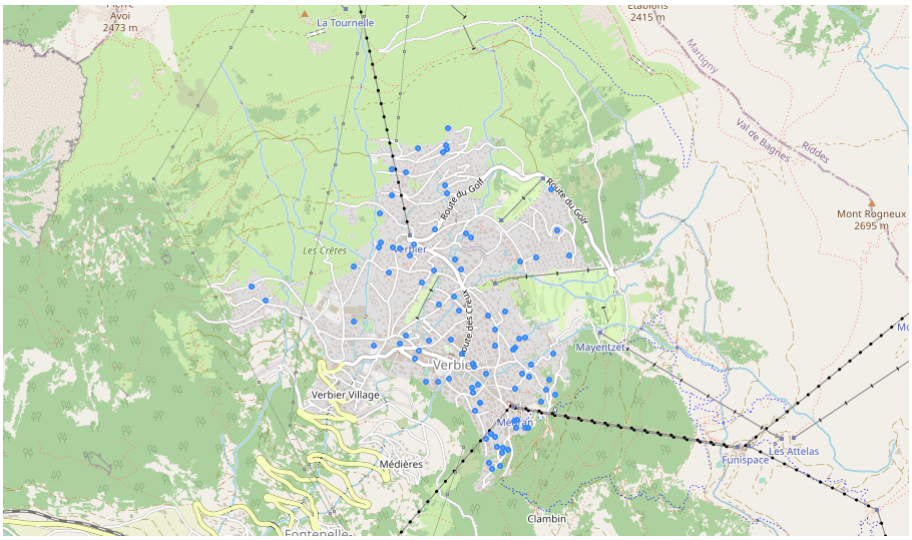
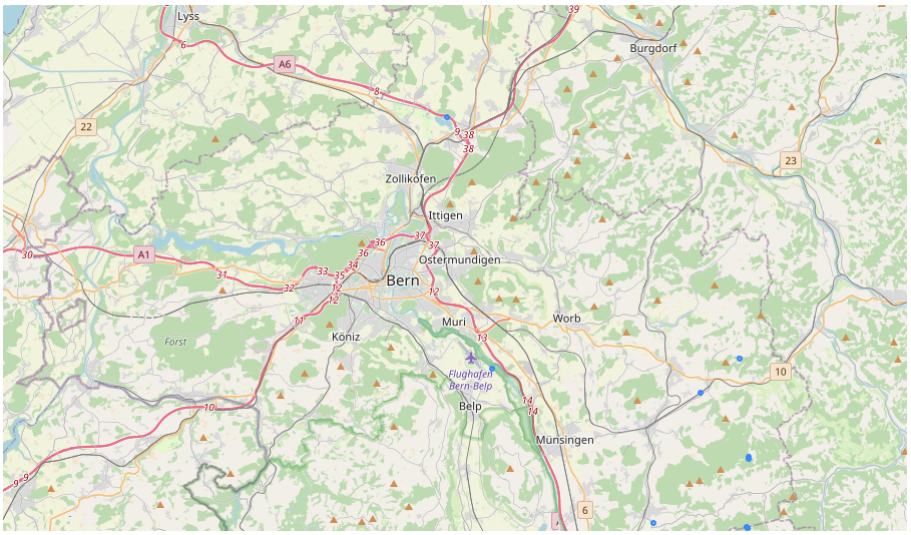


Figure 3: Holiday homes in the Bern area according to Openstreetmap



With the underestimation of the number of holiday homes in Switzerland from Openstreetmap and the total number of average daily overnight stays in holiday homes from the supplementary accommodation statistics (PASTA) (see Section 2.1 and in particular Table 1), holiday homes have, in our model, an average occupancy of 9 tourists per night.

2.5.3 Collective accommodations

1'132 collective accommodations were downloaded using the tags `tourism=hostel` (323 cases), `tourism=alpine_hut` (648 cases) and `tourism=wilderness_hut` (161 cases). It includes 50 observations with the number of beds, 40 observations with the number of rooms, 128 observations with `capacity`, and 1 observation with `capacity:persons`.

This number of collective accommodations is underestimated in comparison with the 2'346 collective accommodations estimated by the Federal Statistical Office in 2021 (Swiss Federal Statistical Office (FSO), 2023).

2.5.4 Campsites

The tag `tourism=camp_site` provides 546 results for Switzerland. Of these, 2 have a value for `capacity:persons`, 31 for `capacity`, 4 for `capacity:caravans`, 2 for `capacity:pitches` and 1 for `capacity:tents`.

This number of collective accommodations is overestimated in comparison with the estimated 397 campsites according to the Federal Statistical Office in 2021 (Swiss Federal Statistical Office (FSO), 2023).

3 Structure of the model

The model can be decomposed into three steps. First, we build a tourist population, which includes information on the location of the stay (x-y coordinates), the type of accommodation (e.g., hotel), some characteristics of the accommodation (e.g., number of stars of the hotel), and the country of origin of the tourist. In a second step, we model the mobility resources. Specifically, each tourist is associated with a main transport mode and, if the main transport mode is rail, with a specific train ticket type. In a third and final step, each agent is assigned a daily activity plan, complete with destinations and trips to these destinations.

3.1 Tourist population

3.1.1 Yearly to daily data

First, the annual data from the two FSO tourist accommodation surveys, HESTA & PASTA (see Section 2.1), are converted into daily data by dividing by 365 and rounding, while keeping the initial sum of tourist agents.

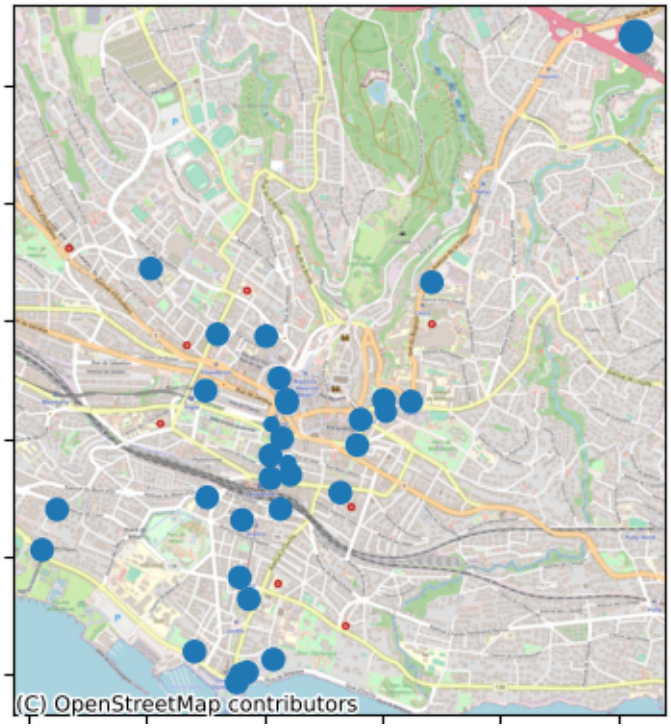
3.1.2 Defining the size of tourist accommodations

In order to distribute the tourists staying in a commune, canton, or major region into the various tourist accommodations in the corresponding commune, canton or major region, we define a "size" for each tourist accommodation.

The size is first defined as the number of beds, if available. If this is not the case, size is derived from one of the different capacity attributes available on OSM. If only the number of rooms or apartments is available, we extrapolate to the total accommodation size by multiplying the number of rooms or apartments by the average number of beds per room (as computed using the available OSM data). If no data regarding capacity is available (i.e. no number of beds, rooms, or apartments provided), we simply use the average number of beds in Switzerland in similar accommodations based on accommodations with detailed variables.

In a future refinement, one could impute missing bed data using the average number of beds by region or canton rather than the whole of Switzerland. In Geneva, tourist accommodations had an average of 140.5 beds available in 2021, while in the Jura and Three Lakes region the average was only 30.3 (Swiss Federal Statistical Office (FSO), 2023).

Figure 4: Example: Hotels in Lausanne according to OpenStreetMap, opened in 2019 or earlier, according to available data. The size of the circle is proportional to accommodation size as defined in Section 3.1.2. We observe that a larger-than-average hotel is located in the north-eastern part of the commune.



3.1.3 Distributing tourists in accommodation per aggregation level and based on size

Once the size of the tourist accommodations is computed, tourists are randomly distributed into hotels or supplementary accommodations in proportion to accommodation size. This is done at the most detailed available aggregation level. For hotels in communes with three or more hotels, the aggregation level is the commune. We thus distribute the number of overnight stays in each commune between the hotels located in this commune. If overnight stays exist according to the statistics of the commune, but no hotel can be found on OSM for this commune, tourists are located in the center of the commune. For hotels in communes with less than three hotels, the aggregation level is the canton. The overnight stays of the canton are thus distributed in the hotels in this canton *excluding those communes with three or more hotels*. For overnight stays in supplementary accommodations, including campsites, the aggregation occurs at the level of seven "major regions".

Here we make the assumption that hotels and other tourist accommodations have the

same occupation rate. This could be adapted in a real case study with the input of expert knowledge.

3.2 Main mode choice model

3.2.1 Choice variable: Main transport mode

In this section, we model the choice made by foreign tourists when selecting their main mode of transport for the duration of their trip in Switzerland (distinct from the transportation mode used to enter the country). The model is estimated using the data of the Tourism Monitor Switzerland (TMS) 2017 (see Chapter 2.2). There are 9 main transport modes defined in the TMS:

- bicycle, racing bike, mountain bike
- camper/caravan
- car
- light rail/public bus
- long-distance bus through Europe (with timetable)
- motorcycle
- private tour bus (e.g. for group travel)
- train
- other

The modal shares can be seen in Figure 5. We observe that transportation by car is the first choice for tourists in Switzerland, with 48% of respondents using it as their main transport mode over the course of their trip. Trains are the second most popular mode, with a 36% share. Light rail and public bus are chosen by 7% of respondents.

Differences by country of origin are relevant: Continental-European tourists predominately use a car as their main mode of transport, whereas people from other regions, including the United Kingdom, are more likely to choose rail. Figure 6 gives an overview of the modal split for the 9 most frequently-occuring countries of origin.

Figure 5: Shares of the different main transport modes for foreign tourists in Switzerland

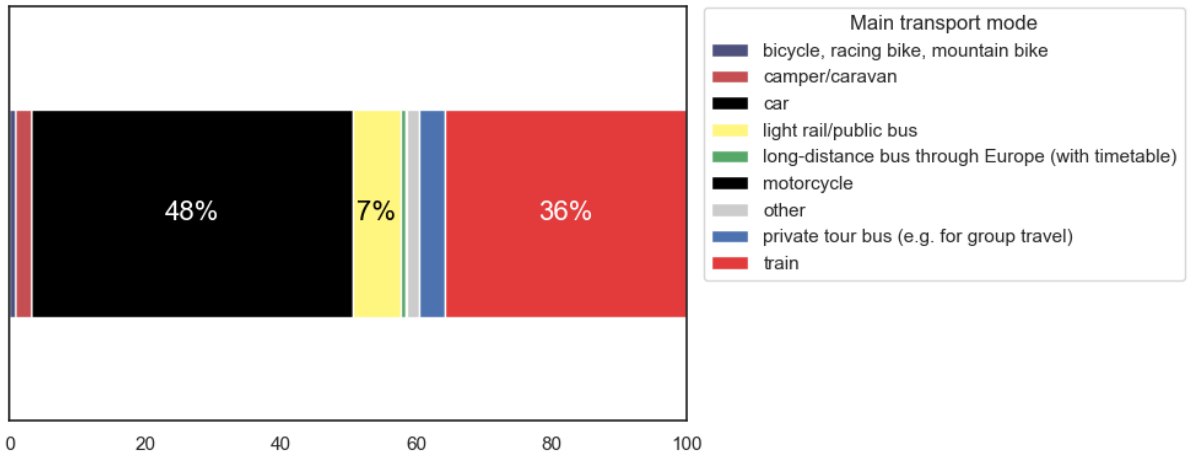
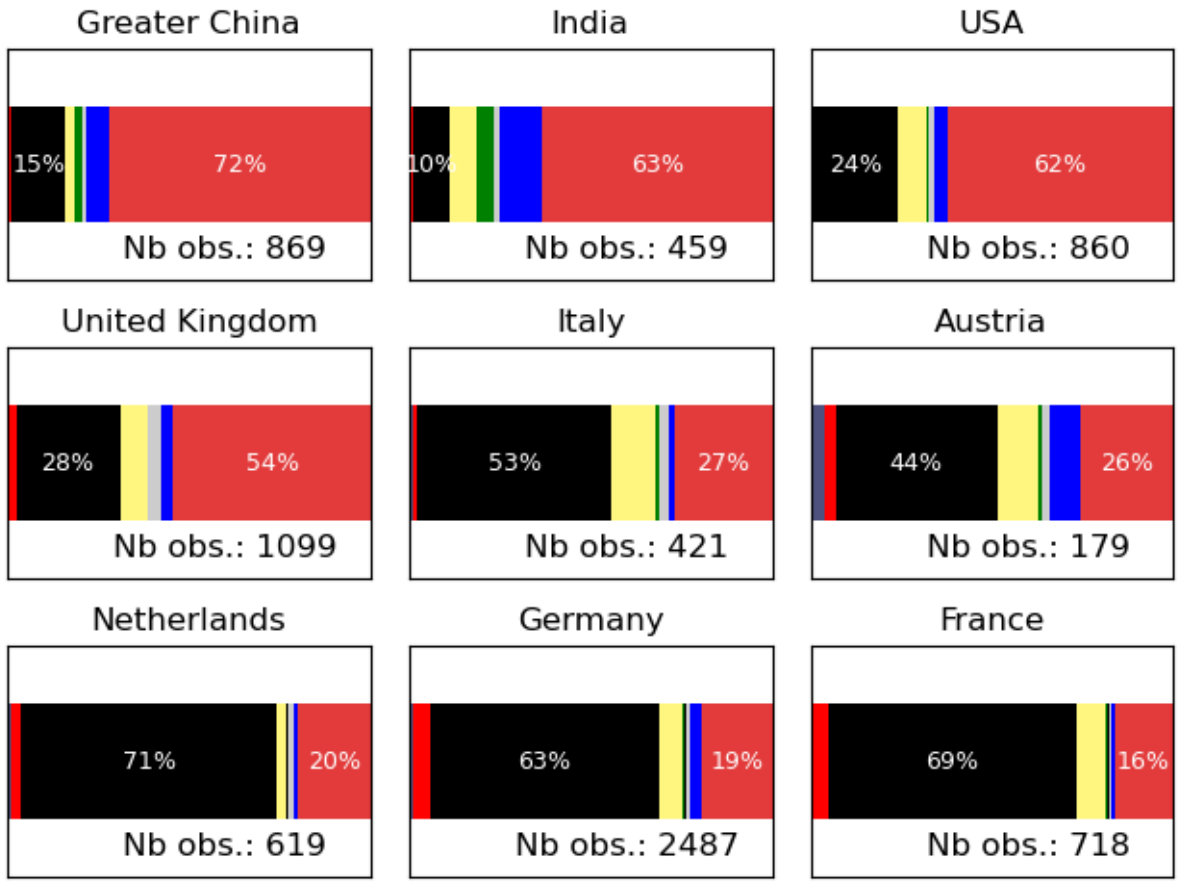


Figure 6: Shares of the different main transport modes for foreign tourists in Switzerland by countries of origin



Notably, the mode choice for travel within Switzerland is likely closely linked to the transport mode chosen to travel from home to Switzerland. In other words, tourists coming to Switzerland by car are also more likely to rely on car as their main form of

transport in the country.

In SIMBA MOBi, the agent-based demand model of the SBB, the transport mode used enter Switzerland (either via an airport or border crossing) is modelled separately (see also Section 1). For now, the selection of transportation mode for entering Switzerland and the primary mode of transportation for travel within Switzerland are modelled independently, without any feedback loops or links between the two models.

For modelling purposes, we consider cars and motorcycles to be a single mode of transportation, and classify "campers and caravans" (as described in the TMS, meaning recreational vehicle - RV, trailers) as "other". The modelled alternatives are thus: train, bus, car and motorcycle, long distance bus, tour bus, bicycle and "other". "Car and motorcycle" is used as the reference value, with an alternative specific constant fixed to zero.

3.2.2 Choice attributes: country of origin of the tourists and characteristics of the accommodations

We tested the following attributes in the model:

Country of origin as declared in the Tourism Monitor Switzerland. After excluding people with residence in Switzerland, 34 different countries of origin are declared, plus one additional category ("other").

Type of tourist accommodation in which the person stays while traveling in Switzerland. We defined 4 categories: hotels, holiday homes, campsites and collective accommodations. We grouped together "hotel" and "bed & breakfast" from the Tourism Monitor Switzerland (TMS) to define the category "hotel", "rented holiday apartment" and "holiday apartment (not paid)" to define the category "holiday homes", and "mountain hut/SAC", "'youth hostel/guesthouse" and "group accommodation" to define the category "collective accommodation". The accomodation type "campsites" is already defined as a single category in the TMS.

Number of stars of a hotel is partially available from both the TMS and from Openstreetmap data.

Urban-rural typology of the accommodation as defined for each commune by the Federal Statistical Office. The typology uses criteria that are both morphological (density) and functional (commuter flows). It comprises 3 categories: urban, rural and intermediate.

Region of the accommodation We use the "large labour market areas" as defined by the Federal Statistical Office. The 16 regions are defined as areas where most employed persons live and work.

3.2.3 Estimation results

The model was estimated using Biogeme 3.2.8 (Bierlaire, 2020). The sample contains 12'809 observations. 88 parameters were estimated. Tables 4 and 5 show the estimation results.

Influence of the country of residence The choice of the main transport mode while in Switzerland is influenced by the country of origin (Table 4). Tourists from Continental Europe (Austria, Denmark, France, Belgium, Germany, Italy, Poland, Czech Republic, Spain) tend not to choose rail as their main transport mode, while tourists from the United Kingdom, Russia, United States, Canada, Australia, New Zealand and Asia (India, China, Indonesia, Singapore, Thailand, Malaysia) tend to choose to travel by train more often than visitors from other countries. The only exception in this divide between Continental Europe and the rest of the world in the preference for rail is tourists from the Middle East (Saudi Arabia, Bahrain, Qatar, Kuwait, Oman, United Arab Emirates) who tend not to travel by train.

Tourists from Australia, New Zealand, China and India tend to choose tour buses more often than tourists from other countries. On the other hand, tourists from Belgium, Brazil, France, Germany, Denmark, Italy, the Middle East, and Spain choose tour buses less frequently than visitors from other countries.

Austrian and Scandinavian tourists are significantly more likely to choose to travel by bicycle as their main transport mode.

Local modes of public transport, such as light rail or bus, are unlikely to be the preferred main transport mode of Belgian, French, German and Middle Eastern tourists. Tourists from India and Southeast Asia (Indonesia, Singapore, Thailand, Malaysia), on the other hand, use these modes of local public transport more frequently than tourists from other countries.

Table 4: Parameter estimates: Alternative specific constants and countries of origin

	Value	Rob. Std err	Rob. t-test	Rob. p-value
ASC_bicycle	-3.6	0.13	-27.7	0.0
ASC_bus	-2.2	0.1	-22.1	0.0
ASC_long_distance_bus	-5.39	0.3	-18.1	0.0
ASC_other	-2.53	0.13	-19.4	0.0
ASC_tour_bus	-2.46	0.14	-18.0	0.0
ASC_train	-0.066	0.074	-0.90	0.37
beta_america_australasia_train	0.61	0.067	9.23	0.0
beta_asia_train	1.09	0.074	14.7	0.0
beta_austria_train	-0.63	0.177	-3.54	0.0
beta_denmark_train	-0.71	0.25	-2.82	0.0
beta_france_belgium_train	-1.48	0.0966	-15.3	0.0
beta_germany_train	-1.11	0.0698	-15.8	0.0
beta_italy_train	-0.99	0.127	-7.78	0.0
beta_middle_east_train	-0.98	0.168	-5.81	0.0
beta_poland_czech_republic_train	-0.78	0.156	-5.02	0.0
beta_russia_train	0.458	0.169	2.71	0.01
beta_spain_train	-0.696	0.114	-6.11	0.0
beta_united_kingdom_train	0.49	0.0744	6.59	0.0
beta_australasia_tour_bus	0.565	0.23	2.46	0.014
beta_belgium_tour_bus	-0.95	0.29	-3.23	0.0
beta_brazil_tour_bus	-2.48	1.01	-2.47	0.014
beta_china_tour_bus	0.581	0.16	3.57	0.0
beta_france_tour_bus	-2.27	0.42	-5.42	0.0
beta_germany_denmark_tour_bus	-0.801	0.136	-5.88	0.0
beta_india_tour_bus	1.05	0.19	5.52	0.0
beta_italy_tour_bus	-2.08	0.511	-4.06	0.0
beta_middle_east_tour_bus	-1.17	0.365	-3.21	0.0
beta_spain_tour_bus	-2.1	0.508	-4.13	0.0
beta_austria_bicycle	1.37	0.393	3.47	0.0
beta_denmark_scandinavia_bicycle	1.24	0.44	2.84	0.0
beta_belgium_bus	-0.65	0.25	-2.59	0.01
beta_france_germany_bus	-0.29	0.0887	-3.31	0.0
beta_india_bus	1.31	0.173	7.59	0.0
beta_middle_east_bus	-2.01	0.512	-3.93	0.0
beta_southeast_asia_bus	0.59	0.174	3.4	0.0
beta_brazil_long_distance_bus	1.46	0.44	3.31	0.0
beta_china_long_distance_bus	1.44	0.321	4.48	0.0
beta_india_long_distance_bus	2.03	0.354	5.73	0.0

Tourists from Brazil, China, and India travel through Europe by long-distance buses as their main transport mode more frequently than tourists from other countries.

Influence of the type of accommodation As we can see in Table 5, tourists staying at a campsite tend to prefer the bicycle as their main transport mode (with "car" being the main transport mode of reference). The same tourists use local public transport (light

rail, bus), tour buses, and the train less frequently than they travel by car (the latter again being the reference category).

The tour bus is chosen significantly more frequently by tourists staying in collective accommodations.

Finally, tourists staying in holiday homes generally travel by car as their main transport mode within Switzerland, with all other modes returning a negative sign in Table 5.

Tourists staying in hotels with more stars tend to travel less by local public transport (light rail, bus) and by train, and more by tour bus.

Influence of the urban-rural typology of the accommodation commune Tourists staying in rural areas tend to take the train less frequently. This is most probably due to the lack of rail service in these areas. Tourists staying in urban areas tend to use more the local public transport, the train, and both long-distance and tour buses than the car as their main transport mode.

Influence of the accommodation region On top of the urban-rural divide, the region where tourists stay also has an impact on their choice of main transport mode. We observe that "urban regions" (Basel, Geneva, Zurich) welcome tourists choosing to travel by local public transport (light rail, bus). The mode "train" is particularly popular in the Berner Oberland, while long-distance buses are mostly chosen by tourists staying in the regions of Basel, Geneva, Lausanne, Central Switzerland and Zurich.

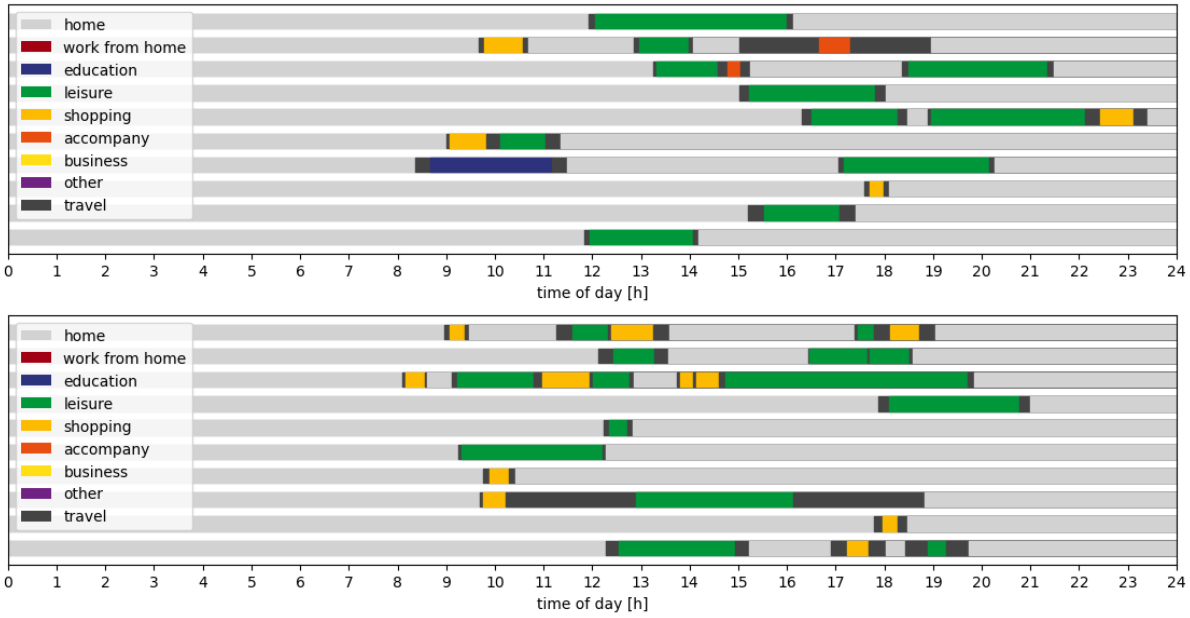
3.3 Choice of public transport season ticket and activity choice using MOBi Plans

SIMBA MOBi uses an activity scheduling algorithm called MOBi Plans. MOBi Plans has been described in detail in Scherr *et al.* (2020). In a first approach, the synthetic tourist population is assigned similar activities as the non-working Swiss population. Since there is little to no data available on the daily schedule of tourists, this approach is a reasonable first start to enrich the model.

Table 5: Parameter estimates: type of accommodation

	Value	Rob. Std err	Rob. t-test	Rob. p-value
beta_camping_bicycle	1.44	0.269	5.36	0.0
beta_camping_bus	-1.48	0.388	-3.82	0.0
beta_camping_other	2.25	0.158	14.2	0.0
beta_camping_tour_bus	-0.991	0.43	-2.31	0.021
beta_camping_train	-1.56	0.188	-8.27	0.0
beta_collective_accommodation_other	-0.956	0.323	-2.96	0.0
beta_collective_accommodation_tour_bus	1.09	0.154	7.05	0.0
beta_holiday_homes_bicycle	-1.52	0.312	-4.87	0.0
beta_holiday_homes_bus	-0.755	0.094	-8.03	0.0
beta_holiday_homes_long_distance_bus	-1.31	0.301	-4.35	0.0
beta_holiday_homes_other	-1.11	0.153	-7.25	0.0
beta_holiday_homes_tour_bus	-2.55	0.258	-9.88	0.0
beta_holiday_homes_train	-0.697	0.0573	-12.2	0.0
beta_stars_bus	-0.0981	0.025	-3.92	0.0
beta_stars_other	-0.141	0.0408	-3.46	0.0
beta_stars_tour_bus	0.164	0.0312	5.25	0.0
beta_stars_train	-0.0488	0.0147	-3.31	0.0
beta_rural_other	-0.478	0.129	-3.7	0.0
beta_rural_train	-0.242	0.0666	-3.63	0.0
beta_urban_bus	0.863	0.1	8.61	0.0
beta_urban_long_distance_bus	1.06	0.324	3.27	0.0
beta_urban_tour_bus	0.578	0.104	5.55	0.0
beta_urban_train	0.916	0.0571	16.0	0.0
beta_region_basel_bus	1.67	0.126	13.3	0.0
beta_region_basel_long_distance_bus	1.58	0.443	3.57	0.0
beta_region_basel_other	1.8	0.196	9.2	0.0
beta_region_bern_tour_bus	0.487	0.227	2.14	0.032
beta_region_berner_oberland_bicycle	-1.07	0.397	-2.7	0.0
beta_region_berner_oberland_train	0.428	0.0586	7.3	0.0
beta_region_bodensee_train	-0.579	0.181	-3.2	0.0
beta_region_fribourg_bus	-1.68	0.715	-2.35	0.019
beta_region_fribourg_train	-0.934	0.225	-4.16	0.0
beta_region_geneva_bus	1.76	0.117	15.0	0.0
beta_region_geneva_long_distance_bus	1.75	0.349	5.01	0.0
beta_region_geneva_other	1.35	0.2	6.74	0.0
beta_region_geneva_train	-0.255	0.0984	-2.59	0.0
beta_region_lausanne_tour_bus	0.502	0.18	2.79	0.0
beta_region_sopraceneri_bus	-1.87	0.596	-3.15	0.0
beta_region_sopraceneri_tour_bus	-1.27	0.523	-2.43	0.015
beta_region_sopraceneri_train	-1.23	0.182	-6.75	0.0
beta_region_sottoceneri_other	1.04	0.377	2.75	0.0
beta_region_westalpen_bicycle	-0.964	0.402	-2.39	0.017
beta_region_westalpen_other	0.425	0.153	2.79	0.0054
beta_region_westalpen_tour_bus	0.53	0.134	3.95	0.0
beta_region_zentralschweiz_long_distance_bus	1.23	0.313	3.92	0.0
beta_region_zentralschweiz_other	0.492	0.155	3.18	0.0015
beta_region_zentralschweiz_tour_bus	0.508	0.125	4.06	0.0
beta_region_zurich_bus	0.966	0.107	9.01	0.0
beta_region_zurich_long_distance_bus	1.81	0.293	6.18	0.0
beta_region_zurich_other	1.04	0.18	5.8	0.0
beta_region_zurich_tour_bus	0.319	0.156	2.04	0.042

Figure 7: Activity plans of 20 agents staying in Interlaken.



A first attempt with 1000 agents staying in Interlaken shows promising results. We observe that the agents mostly perform leisure activities, while still performing some education, shopping and accompanying activities (Figure 7). One agent visits Basel, while others visit Cernier, Thun or Spiez (Figure 8). Most agents, however, stay in the close vicinity of Interlaken (Figure 9).

One feature of MOBi Plans is the modelling of the choice to purchase a season ticket for tourists with public transport as their main transport mode. This choice model has not been developed yet, but could be calibrated using the sales data from the Swiss Travel System (see Section 2.4).

3.4 Calibration and integration in MATSim

In a final step, a calibration of the model using count data from the passenger survey (see Section 2.3) compensates for the lack of data on the distribution of trip lengths by foreign tourists. By comparing the count data for people with seasonal tickets available to foreigners only with the tourist agents generated by the simulation in MOBi sim,

Figure 8: Destination of different activities of agents staying in Interlaken (L stands for leisure, A for accompany, EC for education as non-primary activity and O for other.

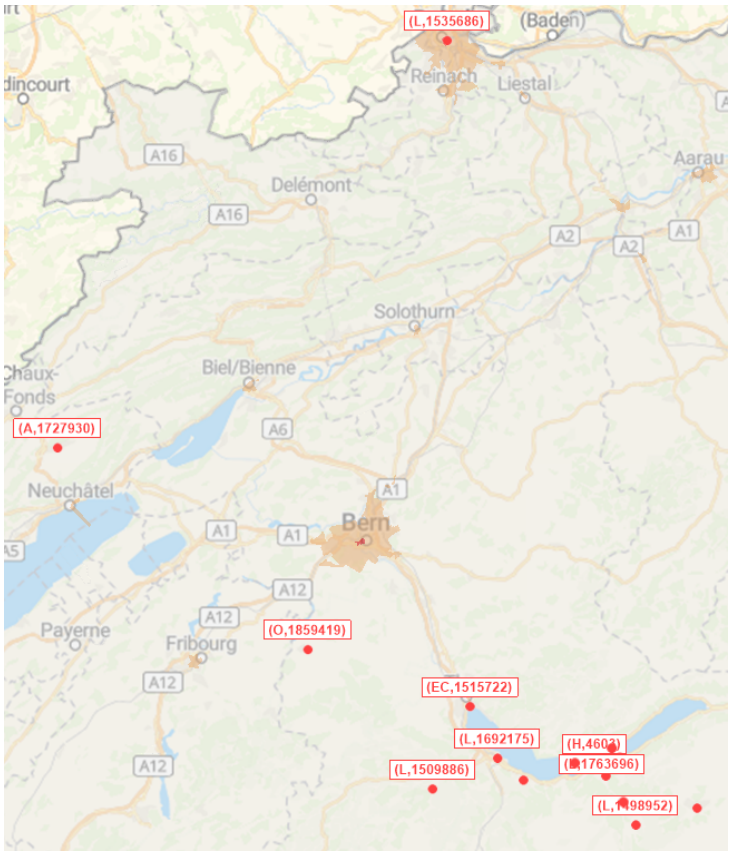
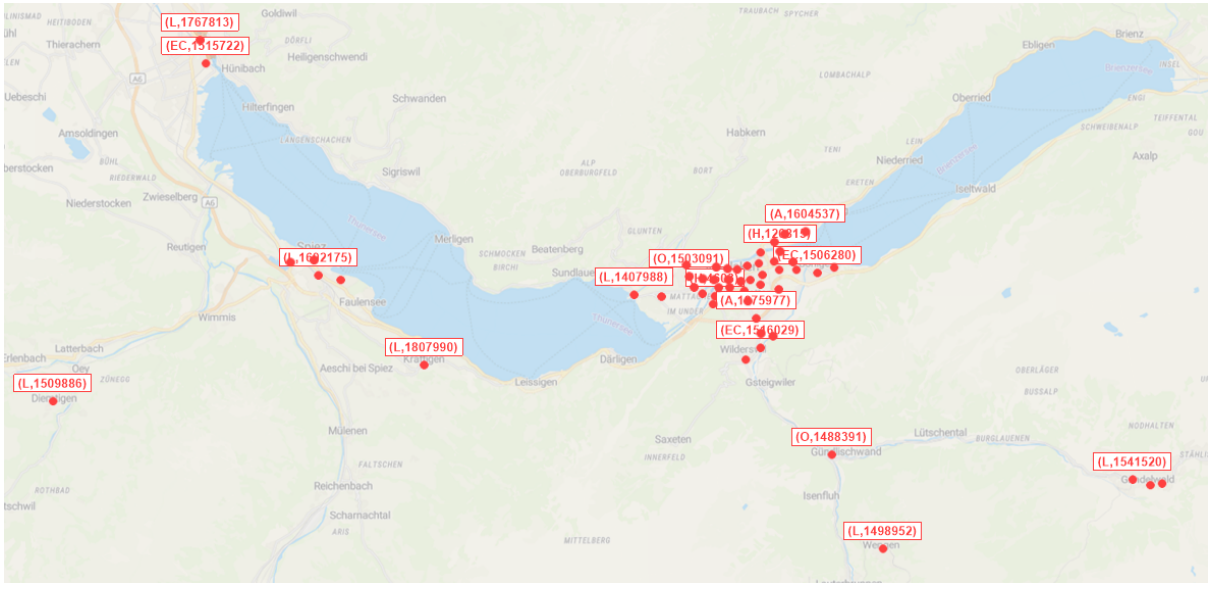


Figure 9: Destination of different activities of agents staying in Interlaken, zoomed on the Interlaken area (L stands for leisure, A for accompany, EC for education as non-primary activity and O for other.



the MATSim-based component of SIMBA MOBi, with similar seasonal tickets, we can calibrate the model and define a scale factor to - most probably - increase the average distance covered by tourists in comparison with the Swiss resident population.

4 Possible applications

The extended model makes possible several applications that could improve rail offerings to tourists. Our model will allow for testing:

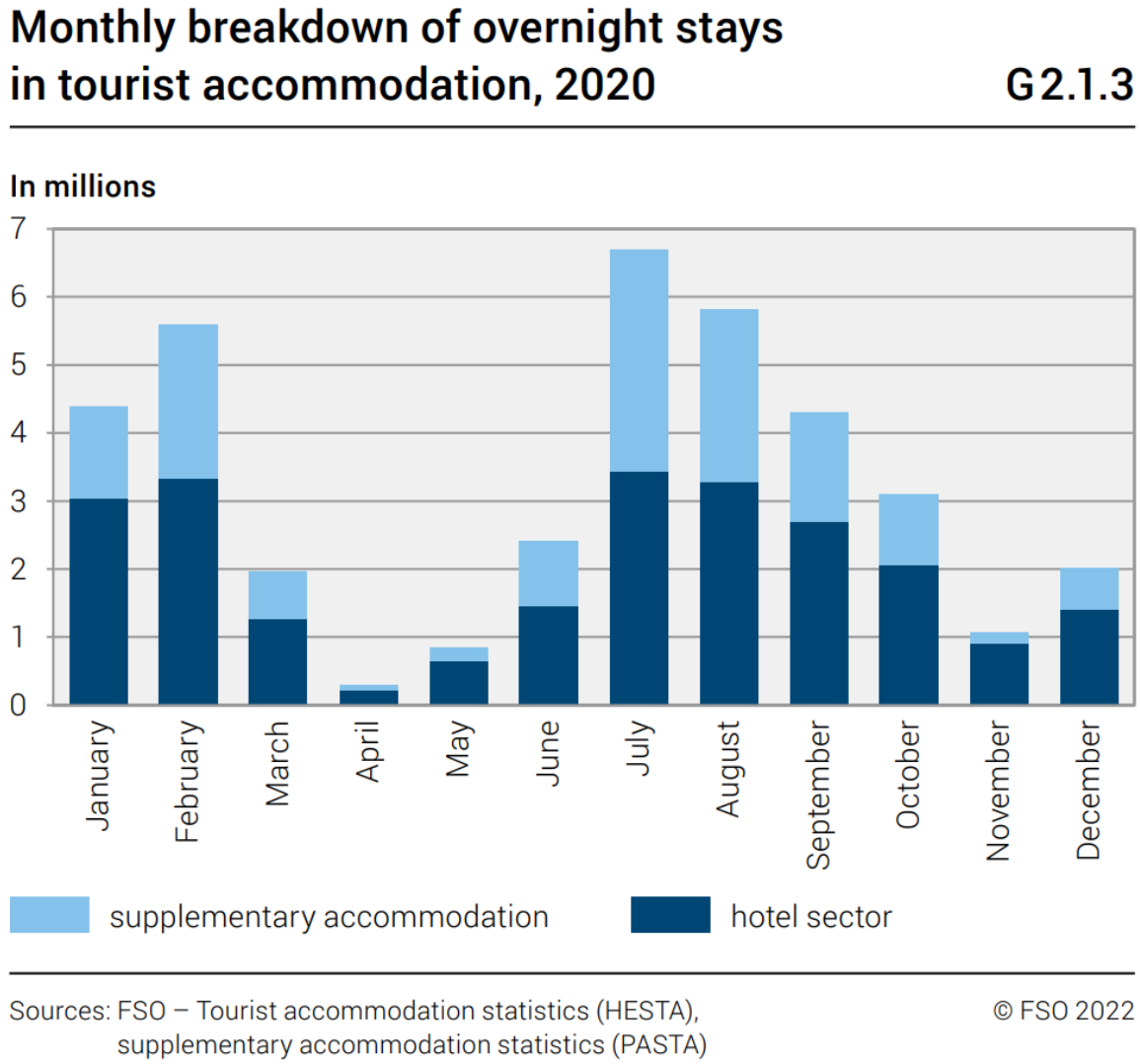
- site developments specifically oriented towards tourism (e.g. new hotels),
- the opening of new attractions / tourist hot spots, such as new museums,
- changes in the markets of origin of foreign tourists in Switzerland, and
- the impact of tourism traffic on railway stations. For example, special guidance systems tailored to tourists could be introduced in highly-frequented stations.

5 Future work

Foreign tourists play a small, but important role for rail travel in Switzerland. This paper presents a model of foreign tourist travel that is still under development. In a next step, the model input data presented in this paper need to be calibrated with the few data sources available. For this, the location choice model, which is currently based primarily on the leisure behavior of the Swiss residential population, needs to be adjusted and extended to cover tourism hot spots, such as hiking trails, landmarks, or cable cars, which are typically not depicted in comparable models. Once this is done, tests on the sensitivity of the model can be performed. For example, a sudden drop in the number of tourists from overseas, as observed during the Covid pandemic, could be simulated.

Lastly, a model depicting an average working day can only be a first step for a model depicting tourism - an industry that is highly seasonal (see FSO, Swiss tourism statistics 2020, 2022, and Figure 10). In the longer term, the model should be able to depict seasonality. This dimension is, however, beyond the scope of the SIMBA MOBi simulation environment in its current state.

Figure 10: Greatest number of overnight stays was recorded in the months of July to October in 2020.



Some technical refinements could be integrated in future versions as well, such as a differentiated occupancy rate of hotels by canton or region (we currently use one rate for all of Switzerland, see Section 3.1.3) or the aggregation of the supplementary accommodation statistics data (PASTA, see Section 2.1) not by the 7 major regions, as in the current iteration, but rather by the 12 tourism regions.

Code availability

The code used for generating the results of the main mode choice model presented in Section 3.2 is available at `https://github.com/antonindanalet/mode_choice_tourists`.

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