How international borders affect local public transport Analyses and evaluations of cross-border agglomerations in Switzerland, France and Germany

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HOW INTERNATIONAL BORDERS AFFECT LOCAL PUBLIC TRANSPORT:

ANALYSES AND EVALUATIONS OF CROSS-BORDER AGGLOMERATIONS IN SWITZERLAND, FRANCE AND GERMANY

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presented by

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« Qu'on en marque les limites. Il n'y a point de bornes dans les choses. Les lois en veulent mettre, et l'esprit ne peut le souffrir. »

Blaise Pascal (1623-1662), Pensées

Abstract

Local public transport is an efficient means to manage the high demand for transportation in densely populated areas and represents thus an important part of urban transport systems. However, where conurbations are crossed by international borders, modal shares of public transport tend to be lower across this border, and local public transport services appear to be less developed than for domestic relations.

This research project therefore aims at identifying the various effects that international borders exert on local public transport systems in high density agglomerations: How do they impact demand? How does the offer of cross-border services actually differ from domestic services? Do cross-border passengers have other expectations towards local public transport services? And what are the specific framework conditions that may impede or stimulate the provision of cross-border services?

These questions have been addressed in order to develop a better understanding of the mentioned effects and to identify the challenging elements, but also to derive approaches how these challenges can be tackled.

While there are many European agglomerations to which these considerations apply, the analyses in this study have mainly been carried out on the basis of case studies in Switzerland, France and Germany, whereof the cross-border agglomerations of Geneva and Basel have been analysed in most detail. An extensive literature review deals with the characteristics of borders and of cross-border agglomerations, with the organisational framework of local public transport, and with the temporal evolution of local public transport services across international borders. Empirical data have been gained on the one hand by means of a dedicated passenger survey that has been carried out on 12 lines in the agglomerations of Basel and Geneva; on the other hand in a work package of spatial analysis with geographic information systems. These data have been complemented with various existing statistical bases and information sources.

Regarding the framework conditions for cross-border local public transport, two main impeding categories have been identified: First, the spatial dimension shows a lower homogeneity of land use patterns and fewer transport infrastructures across international borders. Second, in administrative terms, competences and procedures of authorities and political bodies at either side of borders do not match, and the thin formal and informal interrelations render cooperation more difficult.

The actual offer of cross-border public transport services has revealed the following specific characteristics: Cross-border lines often consist of radial lines and are thereby not well

integrated into the agglomeration-wide public transport network. Therefore, for cross-border trips, changes are necessary more frequently, and only a small share of the population is directly served by cross-border services. The service frequency on cross-border lines is generally lower, fares are less attractive, and service hours are shorter, especially on evenings and weekends. Some of the latter differences, however, are not only a result of the existence of a border, but also a reflection of varying service standards that have become established by transport authorities and operators in the different adjoining countries. Eventually, the commercial speed, as one of the most important service elements, has been found not to differ between cross-border and domestic services.

On the demand side, cross-border trip purposes in Geneva and Basel (but not in Lille and Strasbourg) are strongly dominated by work commuters from France and Germany to Switzerland. This unidirectional and single-purpose demand structure leads to very accentuated demand peaks and results in an inefficient use of transport infrastructures and vehicles.

Surveys have revealed that some cross-border passengers are not as satisfied by public transport services as domestic passengers, but that their expectations towards public transport do not differ significantly from domestic passengers. This allows to conclude that improving service quality and quantity of cross-border services to a similar level as the domestic services would make it possible to engage the unexploited passenger potential and to attain similar modal shares as in domestic transport.

To achieve such improvements in the complicated cross-border context, a series of approaches and recommendations have been derived from the analysis results. These include the application of existing legal bases for the creation of institutionalised cooperation structures among authorities; measures to achieve a better mix of trip purposes and thus a better temporal distribution of demand; and making efforts to achieve more agglomeration-wide uniformity in public transport, including its appearance, information channels, and fare systems.

Zusammenfassung

Der öffentliche Personennahverkehr (ÖPNV) ist ein effizientes Mittel zur Bewältigung der grossen Verkehrsnachfrage in dicht bewohnten Gebieten und stellt ein wichtiger Bestandteil urbaner Gesamtverkehrssysteme dar. Wo diese städtischen Ballungsräume aber durch eine internationale Grenze durchquert werden, ist der Anteil des ÖPNV am Gesamtverkehr meist geringer. Ebenfalls erscheint das Angebot des ÖPNV weniger entwickelt zu sein als im Binnenverkehr.

Dieses Forschungsprojekt hat daher zum Ziel, die diversen Auswirkungen internationaler Grenzen auf den ÖPNV in dicht besiedelten Agglomerationen zu erfassen: Wie wird die Nachfrage beeinflusst? Wie unterscheidet sich das grenzüberschreitende ÖPNV-Angebot tatsächlich von demjenigen des Binnenverkehrs? Haben grenzüberschreitende Fahrgäste andere Erwartungen an das ÖPNV-Angebot? Und welches sind die spezifischen Rahmenbedingungen, welche die Bereitstellung eines grenzüberschreitenden Angebotes erschweren oder erleichtern können?

Die Bearbeitung dieser Themenfelder erfolgte dahingehend, ein besseres Verständnis dieser Wirkungsweisen zu erarbeiten, die problematischen Elemente zu erkennen, und Lösungsansätze zur Bewältigung dieser Herausforderungen abzuleiten.

Auch wenn in Europa zahlreiche Agglomerationen existieren, auf welche diese Überlegungen zutreffen, wurden die Analysen dieser Studie hauptsächlich anhand von Fallbeispielen aus der Schweiz, Frankreich und Deutschland durchgeführt, wobei die grenzüberschreitenden Agglomerationen Genf und Basel am detailliertesten untersucht wurden. Ein ausführlicher Literatur-Überblick beschäftigt sich mit den Eigenschaften von Grenzen und grenzüberschreitenden Agglomerationsräumen, mit den organisatorischen Rahmenbedingungen des ÖPNV, sowie mit der geschichtlichen Evolution von ÖPNV-Angeboten über internationale Grenzen. Empirische Daten wurden erhoben einerseits mittels einer eigenen Fahrgastbefragung, welche auf 12 ÖPNV-Linien in den Agglomerationen Basel und Genf durchgeführt wurde, andererseits in einem Arbeitspaket zur räumlichen Analyse mit geografischen Informationssystemen.

Bezüglich der Rahmenbedingungen für den grenzüberschreitenden ÖPNV wurden zwei Hauptkategorien an Hindernissen erkannt: Erstens weist die räumliche Dimension an internationalen Grenzen eine tiefere Landnutzungs-Homogenität sowie weniger Verkehrsinfrastrukturen auf. Zweitens stimmen die administrativen Kompetenzen und Prozeduren der Behörden und politischen Körperschaften der aneinandergrenzenden Länder nicht überein,

und der beschränkte Umfang formeller und informeller grenzüberschreitender Verflechtungen erschwert die notwendige Zusammenarbeit.

Die Analyse des tatsächlichen Angebotes an grenzüberschreitendem ÖPNV hat folgende spezifischen Eigenschaften aufgezeigt: Grenzüberschreitende Linien bestehen oft aus Radiallinien und sind nur ungenügend in das agglomerationsweite Netz des öffentlichen Verkehrs integriert. Daher sind für grenzüberschreitende Fahrten häufiger mit Umsteigevorgängen verbunden, und nur ein kleiner Teil der Bevölkerung ist direkt von grenzüberschreitenden Angeboten erschlossen. Die Fahrplandichte grenzüberschreitender Linien ist grundsätzlich tiefer als im Binnenverkehr und die Tarife sind in der Regel weniger attraktiv. Ausserdem sind die Betriebszeiten kürzer, insbesondere abends und an Wochenenden. Allerdings sind einige der letzteren Unterschiede nicht nur ein Resultat des Vorhandenseins der Grenze, sondern auch ein Ausdruck der unterschiedlichen Angebotsstandards, welche sich in den verschiedenen Ländern eingespielt haben. Schliesslich wurden in der kommerziellen Geschwindigkeit – einem der wichtigsten Angebotselemente – keine Unterschiede zwischen grenzüberschreitenden und Binnenverkehrslinien festgestellt.

Nachfrageseitig überwiegen bei den grenzüberschreitenden Fahrtzwecken in Genf und Basel (nicht in Lille und Strassburg) Arbeitspendler aus Frankreich und Deutschland in die Schweiz. Diese einseitige und richtungsgetrennte Nachfragestruktur führt zu sehr stark ausgeprägten Nachfragespitzen, welche eine ineffiziente Nutzung der Verkehrsinfrastrukturen und Fahrzeuge nach sich ziehen.

Umfragen haben ergeben, dass einige grenzüberschreitende Fahrgäste weniger zufrieden sind mit dem ÖPNV-Angebot als Passagiere im Binnenverkehr. Die Erwartungen an das Angebot hingegen sind sehr ähnlich für beide Fahrgast-Typen. Dies lässt darauf schliessen, dass eine Verbesserung von Angebotsqualität und -quantität im grenzüberschreitenden ÖPNV auf das Niveau des Binnenverkehrs dazu führen sollte, dass das bisher noch ungenutzte Fahrgastpotenzial im grenzüberschreitenden Verkehr ausgeschöpft werden kann. Damit sollte der ÖPNV einen ähnlichen Anteil des grenzüberschreitenden Gesamtverkehrs übernehmen können, wie dies im Binnenverkehr der Fall ist.

Um solche Verbesserungen im komplexen grenzüberschreitenden Umfeld erreichen zu können, wurde aus den Analyseergebnissen eine Reihe von Lösungsansätzen und Empfehlungen abgeleitet. Diese beinhalten die Nutzung bestehender Gesetzesgrundlagen, um institutionalisierte Strukturen für die behördliche Zusammenarbeit zu errichten; Massnahmen zu einer besseren Durchmischung der Verkehrszwecke für eine gleichmässigere zeitliche Verteilung der Nachfrage; sowie das Bestreben zu einer agglomerationsweiten Einheitlichkeit des ÖPNV, insbesondere bezüglich des Erscheinungsbildes, der Informationskanäle, sowie des Tarifsystems.

Résumé

Les transports publics de proximité sont un moyen efficace pour gérer la grande demande de transport dans des espaces densément peuplés, et ils représentent ainsi une partie importante des systèmes de transport urbains. Cependant, là où des territoires urbains sont traversés par une frontière internationale, les parts modales des transports publics qui franchissent cette frontière sont souvent inférieures aux parts modales des transports publics intérieurs. De plus, l'offre des transports publics transfrontaliers semble généralement être moins développée que l'offre intérieure.

Ce projet de recherche vise donc à identifier les divers effets que les frontières internationales exercent sur les systèmes de transports publics à proximité dans des agglomérations densément peuplées : Comment influencent-elles la demande ? Comment l'offre des services transfrontaliers diffère-t-elle réellement de l'offre intérieure ? Les passagers transfrontaliers ont-ils des attentes différentes des transports publics ? Et quelles sont les conditions générales qui gênent ou stimulent la mise à disposition des services transfrontaliers ?

Ces questions ont été traitées dans le but de développer une meilleure compréhension des enjeux mentionnés et d'identifier les éléments problématiques, mais aussi afin de déduire des approches, comment ces défis peuvent être abordés.

Tandis que ces considérations s'appliquent à une multitude d'agglomérations urbaines en Europe, ce projet a été conduit sur la base d'études de cas en Suisse, en France et en Allemagne, y compris les agglomérations transfrontalières de Genève et Bâle. Ces dernières ont été analysées de manière la plus détaillée. Une revue étendue de la littérature de recherche présente les caractéristiques de frontières et d'agglomérations urbains transfrontalières, avec le cadre organisationnel des transports publics à proximité et avec l'évolution historique des transports publics à proximité à travers des frontières internationales. Des données empiriques ont été rassemblées d'un côté à l'aide d'une enquête-passagers qui a été réalisée sur douze lignes dans les agglomérations de Bâle et de Genève, et de l'autre côté dans un lot de travaux d'analyse spatiale au moyen de systèmes d'information géographiques. Ces données ont été considérées comme complémentaires à des diverses bases statistiques et sources d'information.

Quant aux conditions générales pour les transports publics transfrontaliers, deux catégories gênantes principales ont été identifiées : Premièrement, la dimension spatiale montre une homogénéité inférieure de l'aménagement du territoire ainsi que moins d'infrastructures de transport à travers des frontières internationales. Deuxièmement, dans le cadre administratif,

les compétences et les procédures des autorités et des entités politiques de part et d'autre de la frontière ne sont pas conformes, et la faiblesse des réseaux transfrontaliers, qu'ils soient formels ou informels, rend la coopération plus difficile.

L'offre de transports publics transfrontaliers à proximité a démontré les caractéristiques spécifiques suivantes : Les lignes transfrontalières consistent surtout en lignes radiales et ne sont ainsi pas bien intégrées dans le réseau intégral des transports publics. Par conséquent, les déplacements transfrontaliers nécessitent plus souvent des correspondances au lieu de relations directes, et seulement une petite part de la population est desservie directement par des services transfrontaliers. La fréquence du service sur des lignes transfrontalières est généralement inférieure, les tarifs sont moins attractifs, et les heures d'opération normalement plus courtes, surtout en soirée et en fin de semaine. Toutefois, certaines de ces dernières différences ne résultent pas seulement de l'existence de la frontière, mais elles sont aussi une réflexion des niveaux de service divergents qui se sont établis auprès des autorités et des opérateurs de transport des pays limitrophes. Après tout, la vitesse commerciale – qui constitue un des éléments de service les plus importants – s'est avérée équilibrée pour les services transfrontaliers et pour les services intérieurs.

Du côté de la demande, les motifs des déplacements transfrontaliers à Genève et à Bâle (mais pas à Strasbourg et Lille) sont largement dominés par des frontaliers qui résident en France ou en Allemagne et qui travaillent en Suisse. Cette structure de demande unidirectionnelle et de motif unique conduit à des pointes de demande très accentuées qui aboutissent au fait que les capacités sont exploitées de manière très inefficace, pour les infrastructures de transport ainsi que pour les véhicules.

Des enquêtes ont révélées que certains passagers transfrontaliers ne sont pas aussi satisfaits par l'offre des transports publics à proximité que les passagers intérieurs, mais que leurs attentes à l'égard des transports publics ne diffèrent pas de celles des passagers intérieurs. Cela laisse supposer que des améliorations qualitatives et quantitatives de l'offre transfrontalière à un niveau égal à l'offre intérieure permettaient d'exploiter le potentiel de passagers inutilisé et d'atteindre des parts modales similaire que dans les transports intérieurs.

Afin d'arriver à des améliorations dans ce contexte transfrontalier compliqué, une série d'approches et de recommandations ont été déduites des résultats d'analyse. Celles-ci comprennent l'application des bases légales existantes pour la création de structures de coopération institutionnalisées parmi les autorités impliquées ; des mesures pour atteindre une meilleure hétérogénéité dans les motifs de transport et ainsi une meilleure distribution temporale de la demande ; et des efforts pour atteindre une uniformité des transport publics dans l'agglomération entière, en particulier concernant la présentation au niveau visuel, les voies d'information et les systèmes tarifaires.

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1 Introduction

1.1 Overview

Administrative borders, especially international boundaries, act as a spatial delimitation of political units. While these borders contribute to the spatial definition of the different units, they also have a separating and isolating effect. This effect may be deliberate and necessary for the integrity of the different units and therefore supported by various measures, such as guarding by customs and defence forces as well as infrastructures that may go as far as the Great Wall of China.

However, in Europe, the implementation of multi-nation institutions and treaties, such as the European Union (EU), the European Economic Area (EEA) and the Schengen treaty, contributes to a decrease of the separating effect of national borders. This development also facilitates the cross-border mobility of the inhabitants of the involved countries.

In spite of the periphery of border regions and the disadvantages this incurs, some border regions have identified the presence of different nations at close distance as being even a favourable factor. They ground this on the opportunity of taking advantage of cross-border synergies, which cannot exist in domestically oriented areas: This notably includes the access to two or more countries at short distance, including their labour markets, services and infrastructures. Moreover, the implementation of regional cross-border projects, such as the common provision of hospitals, universities, public services and local public transport are becoming more popular since they can reveal synergies that are to the mutual advantage of all involved countries.

Yet, even though these cross-border activities may be beneficial, their development is still significantly impeded, since the involvement of different political units and their repercussions to legal frameworks, customs regulations, currency uncertainties etc. make them intrinsically more complicated. Moreover, administrative boundaries often coincide with other delimitations – which may or may not be as spatially distinct –, such as language, mentalities and physically separating elements (water, mountains etc.).

Therefore, in order for these borderlands to be economically attractive and to remain steady in the national and international locational competition, they aim at reducing their border-specific drawbacks and boosting their potential for border-induced advantages.

Regarding locational attractiveness in general, an important factor is the presence of adequate, fast and reliable transport systems. This applies especially to urban areas with a high density and accordingly high mobility requirements, where the existence of attractive local public transport – as a part of the entire transport system – is crucial to keep both public and

individual transport systems running smoothly. However, when considering the local public transport systems of agglomerations across national borders in Europe, it can often be observed that the offer of cross-border services is less developed than corresponding domestic services.

In order to enable these agglomerations to take advantage of their border proximity, the promotion of cross-border local public transport is a vital element for the entire border region. As the potential for improvement of such services is deemed as being considerable, this research project has been designed to contribute to a positive development of local public transport in cross-border agglomerations.

1.2 Goal

The aim of the research project is a better functional understanding of local public transport systems in European cross-border agglomerations, with regard to finding solutions to optimise these systems.

The two central research questions have been formulated as follows:

- Which structural characteristics impede the development of cross-border local public transport within cross-border agglomerations, as compared to domestic local public transport?
- How can these impeding elements be overcome in order to strengthen European cross-border agglomerations?

By resuming the current state of research and by combining it with new findings, the present research project aims at furthering the structural understanding of cross-border transport systems. The results should contribute to the improvement of cross-border local public transport as a contribution to an integrated development of cross-border agglomerations.

The research aim mentioned above names two important project delimitations:

- Geographically: The project perimeter comprises the European continent; for case studies, it focuses on Swiss, French and German borderlands due to the high occurrence of cross-border agglomerations in this area.
- In terms of content: The project deals with international cross-border agglomerations only (for definitions see chapter 2.1), even though some phenomena may also be similarly observed at lower-level administrative boundaries, such as those of French Régions, German Länder or Swiss Cantons.

These restrictions are necessary not only to keep the scope of the project at a manageable level, but also to limit the heterogeneity of cases. Legal, economic, administrative and historic backgrounds of areas, but also procedural, mental and linguistic aspects vary greatly between different countries and regions. Such heterogeneity would make it impossible to investigate in-depth and to analyse at a level of detail that allows achieving the research goals.

By means of the clear geographical and content-wise delimitations, it is easily possible to discern the consequences of the restrictions: The project will neither deal with areas that are not adjacent to international borders, nor will it cover areas outside high density agglomerations. It excludes areas outside Europe; European cross-border agglomerations outside France, Switzerland and Germany are not primarily focused on. Consequently, the project will not deliver a comparative study of various cross-border agglomerations; it rather looks at the details and similarities of the mentioned areas and at the specific differences between local public transport on domestic and cross-border relations.

Therefore, the results can achieve a high level of concreteness, enhancing the practicability of conclusions. At the same time, by integrating observations and findings of different cross-border agglomerations, the study covers many different situations, problems and approaches and can thus go farther than single case studies and provide balanced and objective findings.

1.3 Structure of the Project

After having defined the central research question in chapter 1.2, the following section 2 consists in a literature review presenting the current state of research in the fields of both cross-border agglomerations and (cross-border) local public transport. An outline of the historical development is also provided.

From the gaps identified in the literature regarding the central research question, the research interests are derived and explained in chapter 3. The subsequent chapter 4 covers the overall methodological research concept as well as details on the different sets of methods, such as the spatial analysis, the passenger survey and the case studies.

The research results have been divided into two sections: chapter 5 deals with demand-related results, while chapter 6 contains the findings regarding service provision.

The study is concluded by chapters 7 and 8, referring to the research interests and the central research question respectively, and presenting approaches to tackle the identified challenges.

2 Introduction to Local Public Transport in Cross-Border Agglomerations

2.1 Basic Definitions and Delimitations

2.1.1 Introduction

Chapter 2.1 acts as a delineation of the range of agglomerations and of the types of transport considered in this project: It deals with definitions of agglomerations, of cross-border agglomerations as a subset thereof, and sets a spatial perimeter to the considered agglomerations. Furthermore, public transport and local public transport are distinguished from other types of transport.

2.1.2 Cross-Border Agglomerations

2.1.2.1 Agglomerations

2.1.2.1.1 Scope of definitions

Agglomerations have been defined in various ways and in different contexts. The Department of Economic and Social Affairs of the United Nations, for example, use a qualitative definition in their World Urbanisation Prospects Report:

> "The term 'urban agglomeration' refers to the population contained within the contours of a contiguous territory inhabited at urban density levels without regard to administrative boundaries. It usually incorporates the population in a city or town plus that in the suburban areas lying outside the city proper but being adjacent to the city boundaries. (…)" (United Nations Department of Economic and Social Affairs 2012)

An example of a more complex and quantitative definition can be found at the Swiss Federal Statistical Office (Schuler et al. 2005). Here, the term agglomeration is seen as the "spatial extent of urban areas, i.e. the aggregation of core cities and the formally and functionally interwoven surrounding area". To be considered as an agglomeration, the concerned communes must comply with the following socio-demographic criteria:

(a) A minimum total number of 20,000 inhabitants must be reached within contiguous communes

(b) The area must possess a core zone in which each commune has to comply with a minimum number of jobs, both absolutely (min. 2,000 jobs) and relatively, depending on the resident working population (min. 85 jobs per 100 employed inhabitants).

Moreover, to delimit whether communes are part of the core zone as well as of the agglomeration at all, a complex set of further criteria applies, including a minimum share of the resident working population working in the core city, a continuous connection of built up area to the core city (max. 200 m of unbuilt area), high population and job density, above-average population growth and a low share of residents working in the primary sector.

While the latter definition may allow a clear and unambiguous definition of agglomeration areas, its use for the present project has two drawbacks: First, it is geared to the Swiss context, where already quite small settlement areas are considered as urban areas. Using this definition in other countries would presumably result in areas being counted as agglomerations even though they would not consider themselves as such. Second, the scope of statistical data required to test the different criteria exceeds the availability of data in many countries.

Yet another definition was applied by the CONPASS Consortium (2002a), which focused on "urbanised border regions". To be eligible, areas had to have at least one major centre, a total population of min. 100'000 inhabitants, and a maximum of 50-70 km for the agglomeration diameter. Certain additional locational criteria with regard to the border also had to be fulfilled (in this project, these are regarded separately in chapter 2.1.2.3). Those agglomerations complying with these criteria are shown in Figure 2-1.

Due to the not clearly defined threshold values, and the eligibility of rather low-density areas (starting from an average population density of 26 inhabitants per square kilometre), this definition has not been chosen for the present project.

2.1.2.1.2 Applied definition

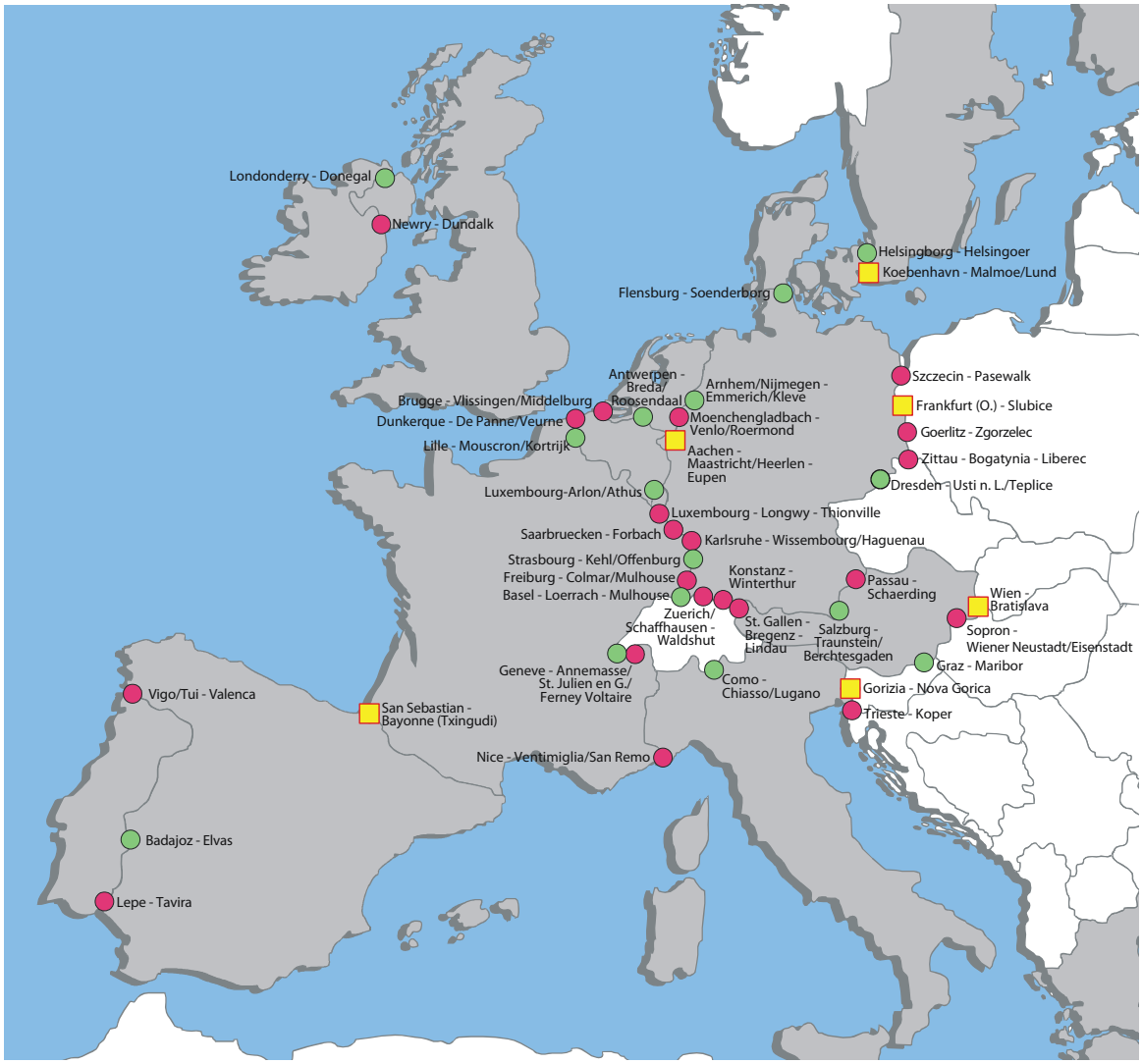
An appropriate solution among a great deal of further definitions has been found at the German Federal Office for Building and Regional Planning (Bundesamt für Bauwesen und Raumordnung 2003). They define 'high density agglomeration areas' ("Hochverdichtete Agglomerationsräume") as areas consisting of:

(a) A principal centre of at least 100,000 inhabitants and
(b) A surrounding area of a minimum population density of 300 inhabitants per square kilometre.

BBR implements this definition on the German 'Kreis' (administrative district) level. Thus, the minimum number of inhabitants must be reached within a 'Kreis' unit, and the minimum population density criterion applies to the average of at least one adjacent 'Kreis'.

Since this definition best describes the type of agglomerations focused on in this project, it is used hereafter. However, as German 'Kreise' do not exist in other countries, and in order to prevent disparities across different countries, the criteria are applied on a communal level.

Figure 2-1: Urbanised Border Regions at 'EU-12' borders according to CONPASS



Source: CONPASS Consortium (2002a), amended

2.1.2.2 Borders, Boundaries

Many definitions exist for the terminology of borders and boundaries; these are often not entirely congruent. While deriving new definitions would go beyond the realm of this work, the use of these terms in this work is summarised in the following:

- Border: the official line that territorially separates two countries ('international border') or other political and administrative units ('lower level border').
- Boundary: a border also in a wider or figurative sense; a point or line, at which one quality stops and another starts.
- Borderland: Area along either side of borders.
- Barrier: A hindering effect or obstacle, which may originate from a border.
- 'Limit', 'frontier' and 'bounds' are other, partially synonymous terms, which are, however, generally not used in this work.

2.1.2.3 Cross-Border Agglomerations

Given the fact that borders can be of different nature (cf. chapter 2.2.2), leading to a considerable variety of conurbations that might potentially be considered as being 'cross-border', we delimit the term 'cross-border agglomeration' to those agglomerations which fulfil the following two criteria:

(a) The agglomeration is transected by at least one international border
(b) The agglomeration has a principal centre acting as such throughout the entire agglomeration (i.e. across borders), even though sub-centres may exist. This especially applies to the function as a centre in terms of the provision of services, jobs and education.

Thereby, we exclude all agglomerations transected by non-international boundaries only (such as county, department, district boundaries etc.), as well as those agglomerations that are only marginally touched by international borders. Example for agglomerations complying with criterion (a) but not with (b) include Nice (France), Donostia-San Sebastián (Spain) or the Ruhr District (Germany), which only very marginally extend across international borders.

We consider the excluded agglomerations to be not sufficiently similar to those agglomerations that the study is aimed at. The latter are namely those agglomerations that are significantly affected by the effects of international boundaries, which specifically include differences in legislation, finance, economy, culture, mentality and possibly language (these elements will be dealt with in more detail in chapter 2.2.2.2). Renouncing this exclusion and maintaining a high heterogeneity of agglomerations is expected to have a blurring effect on the analyses is therefore regarded as not expedient for the purpose of this study.

European agglomerations fulfilling this definition are shown in Figure 2-2.

2.1.2.4 Spatial Perimeter

Even though agglomerations are considered in a generic way as far as possible, the geographic extent of the project has been limited to Europe. This delineation is based on the intention to keep the scope of different backgrounds and framework conditions on a sensibly manageable level. Many considerations, however, are expected to apply to other areas as well.

Interestingly, most of the considered agglomerations are located near the Rhine area, and therefore within the urbanised corridor known as the 'Blue Banana' extending from England to northern Italy. This brings in a certain degree of comparability, especially in terms of the legal and regulatory backgrounds which are limited to a low number of different countries.

Figure 2-2: Cross-Border Agglomerations in Europe according to the Applied Definition

2.1.2.5 Case Study Selection

A further selection has been carried out for the in-depth case study analyses that could not be carried out for all considered agglomerations. This selection intended to include representative range of agglomeration types (size, topological complexity, infrastructures, state of development of local public transport), but also to maintain comparability of legal and regulatory frameworks. The agglomerations of Geneva, Basel, Strasbourg and Lille (see Figure 2-2) best fulfilled these criteria and drew the focus on Switzerland, France and Germany. For reasons of data availability, some analyses were further limited to Geneva and Basel. The characteristics of the case study areas are presented in chapter 4.4.

2.1.2.6 Spatial Extent of Agglomerations

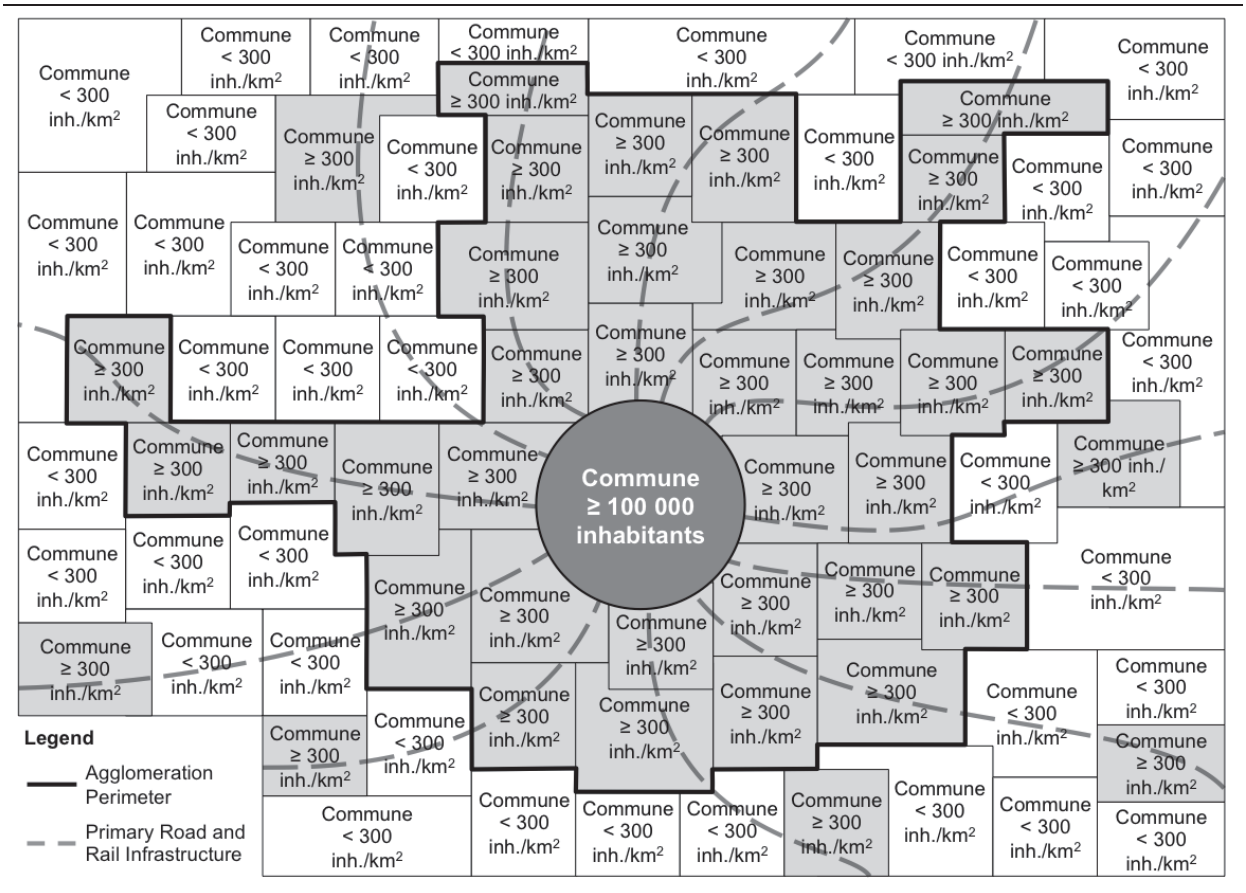
The spatial extent of the agglomerations themselves is determined by population density (according to chapter 2.1.2.1.2), and by their contiguity of communes to the agglomeration centre: Communes are considered as a part of the agglomeration if the following two criteria are fulfilled:

(a) Their average population density exceeds 300 inhabitants per square kilometre
(b) The shortest route from the specific commune to the principal centre only leads through communes fulfilling criterion (a).

Criterion (b) serves to prevent uneven agglomeration outlines or scattered communes within thinly populated areas that would still be regarded as part of an agglomeration.

For a schematic example of the spatial delimitation of agglomerations, see Figure 2-3.

Figure 2-3: Schematic Example of the Spatial Delimitation of Agglomerations



2.1.3 Local Public Transport

2.1.3.1 Public Transport

Based on Wichser, Schneebeli et al. (2005), public transport is considered in this study as a transportation service which operates according to a spatial and temporal definition and which can be used by everybody according to predetermined conditions of carriage; in doing so, it embraces different individual demands and relieves passengers of the need of driving.

For the purpose of this project with its focus on passenger transport, freight transport is excluded from consideration.

2.1.3.2 Local Public Transport

Local Public Transport is seen as a subset of public transport, by which passengers are carried on a local scale. In urban areas, public transport carriage on a local level typically includes the modes of urban buses, tramways (including LRT), metro and local railway services (such as ‘S-Bahn’ or ‘RER’), as well as local boats and cable cars. In some cases, public transport products designated as ‘regional’ (such as some German ‘Regionalbahn’ and certain French ‘Train Express Régional’) can also serve as a means of local public transport. However, interregional, intercity and other long-distance services do not belong to local public transport and are therefore not further investigated in this project.

2.2 Characteristics of Cross-Border Agglomerations

2.2.1 Introduction

Chapter 2.2 deals with specific attributes of cross-border agglomerations: Borders, cross-border mobility and organisational structures. It thereby shows the framework conditions that transport systems face in these areas. The characteristics of transport systems themselves will be dealt with subsequently in chapter 2.3.

2.2.2 Borders

2.2.2.1 Emergence of Borders

Drawing borders and distinguishing between two sides is a very human matter. It is the way that our brains work so as to order the countless impressions that we experience. Here / there, important / unimportant, possible / impossible, safe / dangerous legal / illegal, and good / bad are just some of the various distinctions, with which we draw – usually unconsciously – innumerable delimitations in our everyday lives. It is not by chance that the word 'borderline' can also be used as an adjective when it is difficult to decide whether a case, a candidate etc. is acceptable or not, since the 'border' to be drawn could be either above or below.

On the contrary, borders do not exist in nature. The axiom "natura non saltum facit" (as used e.g. by Leibniz (1704), and allegedly dating from ancient Greece), suggests that borders are always artificial, even though they may sometimes appear as natural. Pascal (1670) noted that "there are no fixed boundaries (…); law wishes to impose them, but the mind will not bear them" (cf. introductory quotation of this book). According to Strassoldo (1982), the longing for the abolition of differences – i.e. removing the boundaries between groups and (social) classes – has emerged again and again in the history of civilised man.

Yet, it is not possible to imagine a world which is borderless and thus undifferentiated and homogenised (Newman 2006). By realising that borders are necessary for the persistence of valuable differences between systems, cultures and organisations, their necessity is no longer in question (Strassoldo 1982).

The development of borders in the sense of a national, territorial distinction is historically strongly connected with modernisation processes: from disorganised, open and primitive areas to more organised and modern ones (Strassoldo 1982). Thereby, in pre-industrial Europe, one of the best developed border systems was not the delimitation between different countries, but the separation of towns from the countryside (Löfgren 1999). Only later, much energy was shifted from the centres to the periphery in order to defend the territory of a country.

Also, up to the Middle Ages, a border was rather an imprecise transition area with frequent relocations, many enclaves, indentations, and confused legal and fiscal situations. Only the subsequent emergence of centralised states rendered borders more linear and stable (Bavoux and Chapelon 2014).

These borders – most of which have been dislocated in the recent centuries in spite of considerable defence efforts – have usually been superimposed by a decision-making elite on the tables of diplomatic conferences (Strassoldo 1982; Newman 2006). The resulting discrepancy between political borders and the true cutting edge of intergroup difference has ben a constant phenomenon in history (Newman 2006).

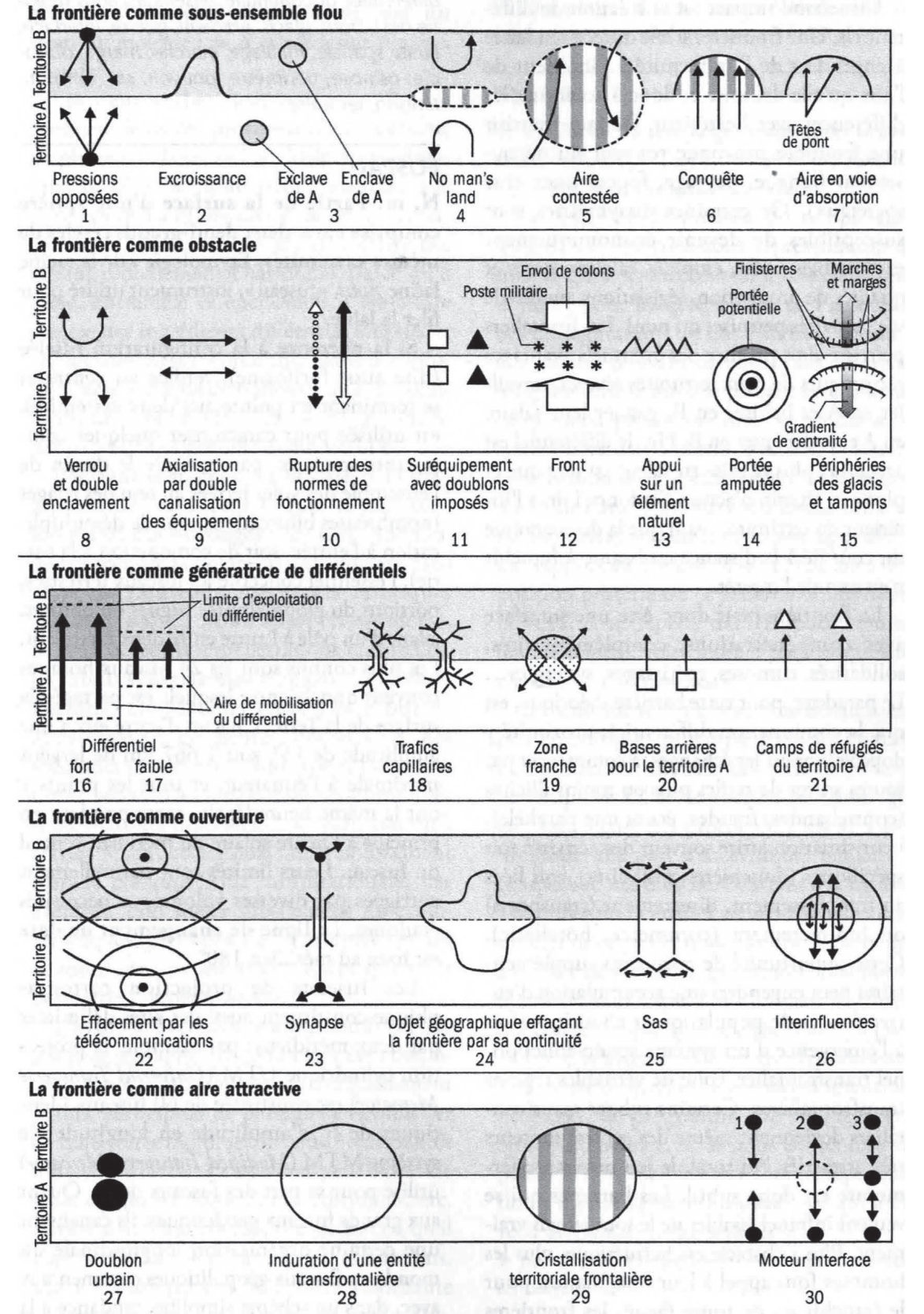
However, to draw such a clear and objectively just line is quite impossible. In this regard, Mayhew (1971) noted that "it is the overlapping character of the boundaries of our social systems that explains much of the tensions and dynamics of social life". This is probably why in the recent decades, although borders in Europe may well have been up- or downgraded, they have not been shifted wherever possible.

In the course of the 20th century, the appearance of borders in Europe has changed significantly: With the emergence of high-capacity transport systems and mass tourism, border crossing points became more visible and elaborate (Löfgren 1999). A new focus was put on the control of duty-free products, of drug traffic and also of illegal immigration. This development was tightly connected with a production of anxiety and with an increased focus on national differences (Löfgren 1999).

Currently, it seems to be a widely accepted view that by means of the process of globalisation, and the European integration, borders would generally be opened and their significance would be decreasing. While this may be true to a certain extent, the importance of borders has on the contrary increased in some ways. After the events of 9/11 and also at borders frequently crossed by refugees, a tightening of border controls can be observed. In the European Union, the free movement of persons within Schengen countries is contrasted by a sealing of the external border of the EU, where it becomes increasingly difficult for the local population, if not impossible, to cross this border (Leuthardt 1999). Moreover, even if a border should be opened to a certain extent, this does not automatically result in a hybridisation of ethnic and national identity (Newman 2006).

Therefore, a closing or an opening phenomenon of borders always concerns only a part of the complexity of a border and has spatially distinct effects. Moreover, such processes can be of different duration, often proceed simultaneously and may be both aligned or opposed. An array of possible effects according to Bavoux and Chapelon (2014) is shown in Figure 2-4. The different functions of a border are considered in more detail in the next chapter.

Figure 2-4: Functional Effects of Borders



Source: Bavoux and Chapelon (2014)

2.2.2.2 Functions of Borders

An international border as the administrative delineation of national territories is not simply a line on a map, but it also incurs a number of consequences: It directly impacts the political systems, authorities, laws, and various policies such as tax and welfare, which apply within the two (or more) contingent areas. An international border thus acts as a dissociation line in various regards. An overview of these border functions by Köppen and Kortelainen (2009) is given in Table 2-1.

Table 2-1: Functions of International Borders

Legal function	Definition of areas with different jurisdiction
Control function	Control of flows of goods, people, capital and services
Fiscal function	Border as an instrument of financial and economical policy (introduction of customs duties)
Military function	Monitoring and securing of borders for the defence of sovereignty
Ideological function	Consolidation and confirmation of the own identity by dissociating from neighbours

Source: Köppen and Kortelainen (2009) based on Lezzi (1994)

In addition to the function of an international border as a man-made line that spatially separates political entities and their territory, they usually coincide with other types of boundaries and limits, such as cultural and social boundaries (cf. Leimgruber (1991)), which are not of minor importance for the purpose of this study.

Such non-political boundaries arise from a variety of characteristics by distinguishing one homogeneous area from another. The characteristics leading to such boundaries are extremely manifold and notably include, amongst others, the following interrelated and dynamic themes:

- Population (language, mentalities, education, age structure, traditions, religion, beliefs);
- Economy (economic system and performance, purchasing power, currency, price and wage levels, level of employment, services available to the public);
- Land use (settlement density, availability of infrastructures).

Some international borders also coincide with physical shapes, such as rivers, lakes and mountain ranges, or man-made border (defence) infrastructures. This makes their appearance more evident and may help to define precisely the geographic course of a border. Such shapes may additionally reduce the border permeability by making the border physically impassable

(e.g. high mountains or wide rivers). However, the above boundary functions are barely affected by physical shapes.

The effect of a boundary described as 'ideological function' is of special importance. This covers the entire concept of 'borders in mind' that goes beyond the objective characteristics of an international border. Löfgren (1999) argues that in spite of global deterritorialisation and deregulation tendencies, there is today an astonishingly strong identification of the population with their nation states: The nations act as a 'home-like' place, where the individuals fit in, belong to and know the unwritten rules. The great importance of language is to be stressed in these aspects (Newman 2006).

In addition to national ties, regional affinities often act complementarily. Löfgren (1999) even argues that people increasingly interpret cultural differences between the two sides of a border as national, not local, regional or class differences. Therefore, the construction of borders may serve to create a new set of 'others' which had not previously existed (van Houtom and van Naerssen 2002).

The mental impact of a border becomes especially evident at the occasion of a border crossing: In border controls, even if they are at random, everybody is (and feels) suspect. Yet, the selective treatment according to the people's look and nationality makes some intrinsically more suspect than others. As passports or ID cards justify the right to cross borders, many people have strong identification ties with their passport details (a – possibly outdated – photograph, names, dates and especially the nationality), even though these indications only represent a very small part – if at all – of their real identity (Löfgren 1999).

These strong national identification tendencies, which stress the 'borders in mind', are of special importance in the present study, since they affect the human decision making: Van Houtum (1999) found that while the distance to the other side of the border might be quite small, the mental distance is often far greater. Moreover, he argues that "economic actors are not only incapable of gathering all the relevant objective information, but are also not always fully willing to do so. (…) In short, the rationality of economic actors (…) is not only physically, but also mentally bounded."

2.2.2.3 Intensities of borders

All these different facets of boundaries, and especially their combination by spatial coincidence, lead principally to a separating effect between the concerned areas. However, apart from this function of a dividing line, borders can in some cases also lead to a contact zone between the contingent areas (Ratti 1991; 1993a). In reality, both functions – dividing line and contact area – are simultaneously active, leading to a mixed effect. The relative importance of these two elements is variable and depends from historical contingencies (Ratti 1991; 1993a).

The level of permeability of a border is dependent from various border functions and effects. As most of these functions and effects are under continuous, gradual change, this also applies to the permeability. Three typical levels of border permeability are shown in Table 2-2.

Table 2-2: Permeability of Borders Dissociating Two Countries

Border = Barrier	Fiscal, control and legal functions fully developed
Border = Filter	Fiscal and control function partially open, possibly legal function partially open
Border = Open contact area	Fiscal and control function open, legal function partially open

Source: Lezzi (1994), Ratti (1991) and Guichonnet and Raffestin (1974)

The level of permeability of a border has an important impact on the development opportunities and thus the locational attractiveness of borderlands. Already Christaller (1933) recognised in his 'central place theory' the significant separation effect of borders and its adverse economic impacts. Thus, in the first case of a border exerting a strong barrier function, the development of borderlands is disadvantaged by their limited hinterland as their trading area, by their peripheral location regarding the national economic centres, as well as by a tendency of central governments to focus on sectorial politics rather than on regional socio-economic matters (Ratti 1991).

In the second level of permeability, where the border acts as a filter, some cross-border interaction is possible, while some distortions and differences remain (deliberately or not). Specific benefits can be drawn from this situation, especially if they are directed at taking advantage of the differences between the two countries: differences in taxation, different price and wage levels and access to certain resources (including human resources and know-how) across borders are some of the elements that open specific economic opportunities. Ratti (1993b) mentions as typical results from this level of border permeability the flow of foreign workers and cross-border commuters, as well as the opportunity of smuggling as a business. Since the remaining differences are often discriminating – cross-border advantages cannot be made in both directions –, the resulting development at this stage is in many cases of unilateral nature.

In the third case, however, where the openness of the border predominates, the regional development is no longer based on benefits from differences between the two countries, but on the real advantages of the entire, bi- or multi-national cross-border region (Ratti 1991).

2.2.2.4 Variation of Borders and its Management

In addition to variations in terms of functions and intensities of borders, their geographical location also varies over time. Many cross-border agglomerations have not always been transected by an international border, while other agglomerations have found their border being removed or downgraded. In Europe, a considerable number of such changes has happened in the last two centuries, especially at the time of the Congress of Vienna (1815), during the two World Wars and from 1989 to 1991. As Waterman (1994) succinctly noted, "if history teaches political geography anything, it is that nothing is static".

As a consequence, borderlands are continuously exposed to changes in political and non-political boundaries that coincide at their international border. This variation is generally disadvantageous, as it implies a low planning security and may also lead to complicated legislation. The task of dealing with these variations involves the following three main components:

(a) Infrastructures

The utility of infrastructures is especially susceptible to becoming obsolete through the shifting of international borders. This applies to both infrastructures along borderlines with protecting and monitoring functions, and – to an even greater extent – the network infrastructures extending throughout the borderlands (Rieder 2014). The implementation of the necessary actions may be difficult due to the involvement of a multitude of authorities and a traditional focus of authorities on national agendas.

(b) Regulation and administration

For both inducing and reacting on the development of borders, laws, regulations and the organisation of administrative processes in borderlands, or even in the entire countries, need to be adjusted. With reference to Table 2-1, this essentially involves dealing with legal, control, and fiscal functions, and is thus directly influencing the permeability of a border. To enable such changes, political and administrative structures need to be reconciled with the new border conditions. The adjustment of these factors is a prerequisite to be able to address point (a) infrastructures.

(c) Perception and informal networks

This is arguably also the most difficult element to manage: Cross-border perceptions as a result from personal long-time experience and impressions and cannot be abandoned at short term. They may often be blurred or even unconsciously biased by the ideological function of a border. Giving up prejudices and, more importantly, building up trust and informal networks is a lengthy process and may even require changes of generations to be completed.

Such 'borders in mind' are difficult to perceive, but also to influence. Yet, they clearly influence spatial behaviour (Köppen and Kortelainen 2009). They are therefore probably the most important element, as they are a precondition to (b) regulation and administration, which is again a prerequisite to (a) infrastructures.

2.2.3 Cross-Border Mobility

2.2.3.1 Co-existence of Different Traffic Types

When considering the effect of borders on mobility and the resulting traffic, it is possible to differentiate three different types of local and regional transport:

(a) Traffic reduced and / or diverted by borders
(b) Border-induced traffic
(c) Border-independent traffic

These three types of traffic usually co-exist, but their relative shares vary in dependence of the characteristics of the border and the agglomeration. Factors influencing these shares notably include border permeability (e.g. transport offer and infrastructures), differences between the involved countries (e.g. economical differences) and the characteristics of trip generation elements in the agglomeration (e.g. resulting trip purposes).

Additionally, patterns differ clearly between urban and more remote areas, and also between local, regional and long-distance connections. However, it is not possible to discern a clear spatial differentiation between these traffic types, since they always overlap.

2.2.3.2 Barriers to Cross-Border Mobility

The existence of an international border within an agglomeration, as well as its level of permeability, with the various repercussions as described in 2.2.2, has an influence on the spatial interactions and the mobility behaviour of the population within the agglomeration. In many cases, the impeding effect of borders on mobility is considered to be predominating, even though borders can also stimulate spatial interaction (cf. chapter 2.2.3.4). If we focus on the hindering effects to mobility in the first instance, it is possible to distinguish the following barriers:

Table 2-3: Barrier Effects of Borders

Preferences	Preferences of consumers for domestic rather than foreign products and destinations
Public sector regulation	Taxes or other limitations on cross-border trade and transport imposed by national states
Institutions	Differences in institutions at both sides of the border
Information	Lack of information on foreign countries
Transport costs	Weak or expensive infrastructure services for international links

Source: Rietveld (2012)

Against this background, Knowles and Matthiessen (2009) note that "transport helps to shape opportunities for, and patterns of, activity and development" and that "transport infrastructure development can remove or reduce existing spatial barriers and bottlenecks".

While Table 2-3 summarises the elements that are reducing the demand for cross-border traffic in general, it might also be worthwhile to focus on public transport specifically. Local cross-border public transport lines often suffer from typical 'border symptoms', which act as an additional barrier to cross borders for (potential) public transport users. Some of the most frequent obstacles are listed in Table 2-4 (for details about their causes, see chapter 2.3).

In addition to these hard, measurable factors, there are also psychological, possibly unconscious barriers to cross borders, and especially to do so by public transport. Differences in mentality and behaviour of the local population may lead to unfamiliarity and unease in areas beyond a border. In contrast to people travelling in their own car, public transport users are more exposed to these factors.

Dziekan (2008a) showed that while people know their way around in their own environment, they lack this knowledge when they travel in unknown areas. Therefore, in order to improve the ease-of-use of public transport, it is important – in addition to the above-mentioned factors – to reduce the traveller's uncertainty by providing him with the right information at the right time, in an understandable way (Dziekan and Dicke-Ogenia 2010). This appears to be a challenging task in the case of many cross-border connections.

Table 2-4: Typical Obstacles for Using Local Cross-Border Public Transport

Information (timetables, fares)	• Language problems • Availability of information • Hardly understandable information content • Insufficient co-ordination • Availability of maps
Level of service	• Too few lines • Low frequency • Too long transfer time • Change of vehicles at the border or at the next interchange station across the border • Time losses caused by the cross-border procedure • Missing connections / missing links • Missing co-ordination of timetables • Unreliable public transport service • Different minimum standards between the countries • Time losses due to technical aspects • Low commercial speed • Insufficient quality standard of vehicles
Tariff	• High level of fares for cross-border trips • Non-availability of full range of tickets • Different level of fares between countries • Problems with the distribution channels • No / limited concessionary fares • Restriction in currency acceptance • Complexity of the tariff system • No integration of the tariff systems

Based on Conpass Consortium (2002b), amended

2.2.3.3 Quantifying the Effect of Borders on Mobility

There are different approaches on how the effect of borders can be implemented in quantitative calculations of traffic flows. In the concept of generalised costs, borders can be represented as a fix or variable amount of costs to be added to the other costs components (Rietveld 2012).

Within the gravitation approach, which is often part of traffic distribution models, an adjustment to the gravitation constant or the insertion of a border resistance factor – ideally in dependence of O-D relations and of trip purposes – can represent an estimation of the impact

of the border on traffic flows (Ahrens and Schöne 2008). Interestingly, already Lill (1889), who introduced the gravitation approach to transport planning, discussed the clear influence of national and language borders on the resulting demand for transport.

For both approaches – the generalised cost and the gravitation approach – the values representing the border effect can only be determined by means of calibrations. A short overview over empirically derived border effect quantifications is given in the following.

An early study by Nüsser (1989) compared transport volumes of long-distance national and international flows in some western European countries and observed cross-border traffic flows on a quantitatively much lower level. Even though the study itself raises some limitations about its results due to a lack of data availability, it estimates the order of magnitude of a 'frontier impedance factor' to be as high as 4.7 (i.e. a reduction of almost 80%). Also, it states that cross-border traffic in the considered countries is growing more quickly than domestic traffic. It is therefore not surprising that after around ten years, during which the economic integration was progressing, Plat and Raux (1998), who focused on intercity car traffic volumes on French domestic and cross-border highways, estimated the border reduction factor in a somewhat lower range, namely between 1.7 to 3.0 (i.e. a reduction of between 41% and 67%). For Dutch highways, Rietveld (2001) calculated a border reduction effect of 35% to 48% and observed significantly higher shares of trucks at borders than near borders.

In these studies that focus on long-distance transport, major variations between different border crossings, and especially between different pairs of countries have been observed. However, when considering the effect of borders on mobility on a local or regional level, it is necessary to define such border resistance values on a case-by-case basis, since the dependence of external factors is even more important. The spatial context is of considerable significance: rural areas differ clearly from urban areas, and the regional interrelations across national borders play an important role.

Moreover, when calculating border resistance values, a differentiation according to different traveller types is necessary: some of the most important factors are trip purposes as well as the direction of travel (or the country of residence), since these factors account for significant variations: In the long-distance traffic study by Nüsser (1989), a greater border resistance effect was observed for business purposes, while on a local level, major differences can be observed between commuting, shopping, education, leisure and professional trips (Ahrens and Schöne 2008). Also, traffic volumes can be distributed very asymmetrically, especially in case of a distinct gradient in price and wage levels across borders.

A further complication in determining the effect of borders is the interaction between transport supply and demand. Rietveld (2001) showed that public transport links across borders are much less developed than comparable domestic relations, both for long distance journeys (40% less cross-border services between European cities) and on a local level (60% less services across Dutch borders). Similarly, for road transport, the network density across borders is often lower than within domestic areas. Thus, it is likely that the lower cross-border

traffic volumes are to a certain extent also a result of the fewer cross-border transport links, even though the limited transport connections are also likely to be a result of lower demand.

This complexity in quantifying border effects on transport volumes illustrates the difficulty in quantitatively depicting the effect of borders on mobility. Yet, it seems even more difficult to use these border effect values to project and forecast future traffic volumes, since the manifold influences are mostly dependent on external factors (e.g. differential economic development of involved countries, political and social interrelations and tensions between countries, non-conformity of spatial development etc.) that can at best only be roughly estimated for the future.

An example for inaccurate traffic forecasts is given by the international Öresund fixed link between Malmö (Sweden) and Copenhagen (Denmark): An overestimation of the border effect resulted in actual higher traffic volumes than expected (Knowles and Matthiessen 2009).

2.2.3.4 Border-Induced Traffic

As Ratti (1993a) noted, the border effect consists of two facets: On the one hand, it acts as a demarcation line that separates the regions and countries on either side of the borderline. Yet, on the other hand, it can also be seen as a contact factor or as an intermediary element between different societies and collectives and creating a functional space across administrative boundaries.

It is in the latter case that the border exerts an inducing effect on traffic volumes. In other words, a part of the cross-border traffic would not exist if the border were not there.

The existence of this cross-border traffic induction can result from different incentives, such as:

- Financial incentives: Taxation (shopping, professional), price and wage levels (shopping, commuting, professional), housing market (commuting, professional)
- Regulatory incentives: Opening times (shopping)
- Preference for variety: Range of goods (shopping, professional), Leisure activities and tourism (leisure) (CONPASS Consortium 2002a; Rietveld 2012)

These incentives can either appear as a side effect of differences between two countries, but they may also be a result of strategic developments aiming at integrating agglomerations across borders in order to benefit from local assets of either side of the border and from agglomeration effects in general.

Examples for cross-border areas with distinctive cross-border traffic induction in France are given in Plat and Raux (1998): The Alsace region and locations around Geneva are typical instances.

2.2.4 Organisational Structures

Throughout the literature, a discrepancy between administrative and organisational structures, which often end at political boundaries, and the mobility of people extending across borders, can be observed. This is evident on different levels, including political systems and procedures, the public sector (administration, authorities) and transport operators.

The typical difficulties resulting from this situation for cross-border local public transport are given in Table 2-5.

Table 2-5: Typical Obstacles for Local Cross-Border Public Transport caused by the Organisational, Legal and Institutional Framework

- Different responsibilities of administrations (*)
- Lack of subsidies
- Different legal frameworks
- Problems with licence / concession
- Long decision-making procedure (*)
- Different safety standards
- Different labour conditions
- High investment costs due to a lack of existing suitable infrastructures
- Lack of cross-border co-operation structures (*)
- Restriction of the local planning sovereignty (vs. e.g. national level) (*)
- Insufficient information about regulations
- Little or no willingness to co-operate (*)
- Lack of co-operation between operators (*)
- No authority with arbitrator functions
- Cost and profit distributions / split of revenues (*)
- Demands made by the border police
- Currency variations between the countries
- No usual reduction in taxation

(*) typically also occurs at lower-level boundaries

Based on Conpass Consortium (2002b), amended

Some of the difficulties mentioned in table Table 2-5 can be observed not only at international borders, but also at other, lower-level administrative boundaries. The accumulation and simultaneity of these effects are however much more significant at international borders.

The reasons for the identified lack of co-operation can be found in different elements, such as the principal orientation of administrative structures to nation states and not to (cross-border) regions. Recent devolution and regionalisation developments have mitigated this difficulty in some areas of Europe to a certain extent. However, additional prerequisites for effective

cross-border cooperation are reliable and stable, official and unofficial norms and values, which can only be established in the longer term (Köppen and Kortelainen 2009). A classification of different intensities of cross-border relationships is given in Table 2-6.

Table 2-6: Levels of Cross-Border Relationships

- No relations
- Information
- Consultation
- Coordination
  - Negative coordination: prevent disturbing one another
  - Positive coordination: align the own efforts with common goals
- Cooperation: establish and implement projects jointly
- Integration: common legal basis, actors, resources etc. on a higher administrative level

Source: Lezzi (1994)

2.3 Organising Local Public Transport

2.3.1 Introduction

This section deals with the manifold parameters in the organisational set-up of local public transport. By presenting the most significant differences and similarities between different organisational systems throughout Europe, the overview is illustrated by some typical, representative instances, which are not intended to be exhaustive.

The chapter relates indirectly to the organisation of cross-border public transport by serving as a basis to derive potential challenges which result from the need of integrating into different organisational systems and of adopting multiple regulations.

2.3.2 Legislator

2.3.2.1 Common Features

Legislating institutions are bodies that enact legislation. Usually, they appear in the form of parliaments, consisting of one or more chambers, with members elected by, and representing the population of the concerned political entity during a pre-defined legislative period. Alternatively, in some cases, members of parliament can also be automatically appointed by the fact that they hold a certain office.

Legislators exist on different political levels: The Council of Ministers and the European Parliament represent the highest legislative bodies in the European Union, whereas local (community / borough / district) councils or assemblies act at the lowest level, with several levels in between.

The limitation of competences of different legislators at the same level (horizontal delimitation) is clearly defined by the geographical perimeter of the political units (area of jurisdiction). The vertical delimitation, however, is achieved in terms of content, whereby higher-level legislation usually explicitly devolves specified competences to a lower level.

The principal function of legislating bodies is to approve or reject draft laws and budget proposals that have been prepared by executive bodies (cf. 2.3.3), but they also have the possibility to require amendments and in some cases also to initiate new legislation.

Regarding public transport, legislators are responsible for enacting the entire legal framework including technical and safety standards, employment legislation, administrative responsibilities for organising public transport etc. Moreover, legislators also (dis)approve concrete transport strategies, policies and plans as well as the use of public funds for both infrastructure and operations.

2.3.2.2 Variations

There are some significant variations among legislators throughout Europe. The elements with the most significant differences are summarised in the following:

- The number and the nature of political levels between the lowest (communal etc.) and the highest ((supra-)national) levels
- Distribution of competences and responsibilities among the political levels (e.g. degree of regionalisation / devolution)
- Goals, strategies and priorities of legislating bodies both spatially and in terms of content

Further differences of secondary importance for public transport include the election / appointment procedures, legislation periods, size and composition of legislating bodies etc.

The fields of local public transport affected by differences in legislation between different areas of jurisdiction notably include:

- Operations and safety standards
- Vehicle registration
- Employment regulations
- Accounting and taxation legislation
- Requirements and procedures for obtaining operating licences / concessions
- Existence of stakeholders and their responsibilities
- Modalities for the use of public infrastructures
- Criteria for subsidies
- Degree of regulation or deregulation

2.3.3 Governments and Public Transport Authorities

2.3.3.1 Common Features

Public transport authorities as subordinate institutions of governments are responsible for planning and organising public transport. Similar to the hierarchical structure of legislative bodies (cf. chapter 2.3.2), governments also exist on different levels. Depending on the degree of regionalisation and devolution of the respective countries, responsibilities can be transferred to lower levels according to the principle of subsidiarity.

Due to the distribution of responsibilities throughout the hierarchical political levels, and since public transport involves many different aspects, there always exists a multitude of departments and offices, each of which is responsible for a specific sector of public transport. The allocation of these responsibilities to the different authorities is often carried out according to traffic types (local, regional, long-distance transport) and the different disciplines within transport (infrastructures, development strategies, contracting of subsidised services, vehicle and operations licensing, regulations etc.). Therefore, cooperation among agencies is in all cases a prerequisite for any kind of public transport, even for domestic and local cases.

An important element on the strategic level, for which public transport authorities are responsible, is the design and the implementation of public transport policies, strategies and budget proposals for their respective sector / area of responsibility. Such transport plans should always be congruent with plans and strategies of higher hierarchical levels, and they should as far as possible also be congruent with those of the surrounding areas (at the same level). These plans and budget proposals usually have to be drawn up periodically and are often to be approved by the responsible legislative body.

On a more operative side, transport authorities also plan and order (contract) public transport services from transport operator companies. This is again limited to the area and transport sector of responsibility and therefore coordination with neighbouring and higher / lower-level authorities is necessary also in this case.

2.3.3.2 Variations

Some variations among governments and public authorities are shared with the legislative bodies, while some variations add complementarily.

Variations in common with the legislature are:

- The vertical distribution of responsibilities (segregation of tasks and responsibilities between e.g. cities, regions and the national level, cf. Table 2-7)
- Strategies and priorities to be followed and adopted, in accordance with the requirements of the legislative bodies

Variations that apply additionally are:

- The horizontal distribution of responsibilities (segregation of tasks and responsibilities among authorities on the same hierarchical level / within the same area of competence, cf. heavy rail and metro / tram / bus competences in Table 2-7)
- The procedures of planning processes, planning periods and horizons as well as the instruments and bases (such as surveys and statistical data) used for transport planning.

Table 2-7: Competent Authorities for Public Passenger Transport Services at Different Levels in Different European Countries (simplified)

<table>
<tr><th></th><th colspan="2">Switzerland</th><th colspan="2">Germany</th><th colspan="2">France</th><th colspan="2">Belgium</th><th colspan="2">The Netherlands</th></tr>
<tr><th></th><th>Heavy rail</th><th>Metro, tram, bus etc.</th><th>Heavy rail</th><th>Metro, tram, bus etc.</th><th>Heavy rail</th><th>Metro, tram, bus etc.</th><th>Heavy rail</th><th>Metro, tram, bus etc.</th><th>Heavy rail</th><th>Metro, tram, bus etc.</th></tr>
<tr><td>Urban / local</td><td colspan="2" rowspan="2">Communes</td><td rowspan="3">‘Länder’ or Regional Associ-ations</td><td rowspan="2">‘Kreise’</td><td rowspan="4">‘Ré-gions’</td><td rowspan="2">(Associ-ations of) Com-munes ‘Dépar-tements’</td><td rowspan="5">Federal State</td><td rowspan="5">Regions</td><td colspan="2" rowspan="3">Provinces</td></tr>
<tr><td>Sub-urban</td></tr>
<tr><td>Regional ≲100km</td><td colspan="2" rowspan="2">Cantons</td></tr>
<tr><td>Intercity ≳100km</td><td colspan="2" rowspan="2">Confederation</td><td colspan="2" rowspan="2">Federal republic</td><td colspan="2" rowspan="2">Central state</td></tr>
<tr><td>Long-distance</td><td colspan="2">Central state</td></tr>
</table>

Based on Noelle and Gouin (2006) and UITP-EuroTeam (2010)

2.3.4 Transport Operator Companies

Transport Operator Companies are establishments providing public transport services. They may be in private or in public ownership, or are in certain cases also public bodies (so-called internal operators, i.e. a part of, or owned and controlled by, the public authorities), even though the latter case is becoming less frequent.

The operation of local public transport services is usually not profitable on its own. For the provision of these services, the operators depend on compensation from the public sector (cf. chapter 2.3.6). Marketable services that can be operated on the operator’s own account are either part of the long-distance sector or consist of important conurbation axes with high demand and very favourable operational conditions. Typically, a relative advantage over other modes of transport (travel time, reliability, capacity etc.) is a prerequisite for profitable operations in local public transport.

Even though the margins of profit are usually moderate for the operation of local public transport services, there are a few multi-national operators for local transport services (so-called ‘MOLTS’) that have expanded to many European countries (e.g. Keolis, Veolia Transport, Arriva etc.). Rather than immediate financial profits, their incentive to participate at the market is the comparatively low risk associated with concession and management contracts for local public transport, which enable them to achieve returns that are viable for the capital market. By means of their immense entrepreneurial experience, know-how and instruments, they have good chances to win tendered services in spite (or because) of their lean overhead structures (Shibayama and Brezina 2010).

2.3.5 Transport Associations

In order to enhance the ease of use of local public transport, and to enhance coordination between different actors, transport associations have been established in many European conurbations.

There are many different types of transport associations; some consist of transport operator companies only, while others are focused on transport authorities, with many mixed types complementing the range. Also, the area of responsibility can vary widely. Generally, though, the aim of such associations is to coordinate timetables, fares and other administrative issues in order to optimise the entire system of local public transport. This is of special importance where many subsystems exist in parallel, and where interchanges between different operators are frequent (Knieps 2004).

They can also deal with other issues such as marketing, promotions, customer services etc., but most importantly they serve as a platform to establish and manage common fares and through ticketing. The use of a single ticket that is valid on different transport operator companies has considerably simplified the use of local public transport in many places.

Sometimes, transport associations also assume responsibilities on behalf of transport associations in the process of establishing service offers (cf. 2.3.6), and the affiliation of transport operators to the association and to its rules may be a prerequisite for the operation of services within the area of the association.

On the other hand, transport associations are of rare presence where local public transport services are provided by one single operator, or where the public transport sector has been deregulated in order to allow competition, which contrasts to a certain extent with the idea of transport associations (especially ‘competition *in* the market’, cf. 2.3.6).

2.3.6 Process of Establishing Service Offers

The actual offer of public transport services – the essence of public transport for its customers – is always the result of interaction with the following planning elements: infrastructure, rolling stock and production processes. Together with the offer, these elements constitute the so-called ‘planning quadrangle’ (Weidmann 2008).

Also, the amount of transport services to be offered has to be determined. It can be a reaction to existing demand for transport, it may anticipate future demand or it can also be of strategic nature, such as the provision of a continuous basic service. Most often, all three aspects play a role in defining the level of service provision.

The simplest process of designing, implementing and providing a service concept for local public transport can probably be achieved if both the planning and the operating tasks are carried out by a public authority that exercises a monopoly. In this case, however, there is no clear incentive to provide efficient services, and special care has to be taken in order to allow the system to evolve along with the changing needs and expectations of the population and to make use of innovations.

Therefore, many public transport operators have been disembodied from the authorities or even privatised, and other privately owned operators could enter the market. Competition has been introduced for public transport in some places, with the aim of improving efficiency and better meeting the needs of the market. Today, three different concepts are to be distinguished (White 2002; van de Velde 2006):

- Competition in the market (or on the road): Different operators can compete directly on the same routes and any operator can enter the market with its own concept (such as after the 1980 and 1985 Transport Acts of the UK). Public authorities approve the operations only according to their compliance with legally defined minimum standards. This system stimulates market initiative, but also incorporates the potential risk of market failure, where important services would not be operated at all or at an insufficient level. Competition in the market is most frequent for long-distance transport in some European countries.
- Competition for the market (or off the road): Public authorities conceive public transport operation concepts (incl. some route, capacity, timetable and possibly fare specifications) and award public service contracts to transport operator companies by means of competitive bidding. The contracts may be combined with a financial compensation (in either direction) and / or with the right of exclusive operation on the respective route or in the served area, and may also cover the use of infrastructures (e.g. railway franchise). Depending on the degree of risk and entrepreneurial incentive to be transferred to the operator, the agency can award management contracts, gross contracts or net contracts.

  A potential disadvantage of this approach is the return to more regulation, which could potentially lead to a neglect of the needs of the market.

  In the European Union, so-called 'Public Service Obligations' (PSO) that can be awarded for unprofitable routes that are socially and economically important are primarily used in the aviation sector, but in some cases also for local public transport (European Parliament and Council of the European Union 2008a).
- No competition / direct awarding or internal operation: Based on certain considerations, an authority or a government may decide to exclude public services from competition, but instead to award a certain operator directly. This is often the case for transport modes with a strong dependence of infrastructure and with rolling stock of long amortisation periods (such as heavy rail). Direct awarding is also frequently applied for publicly owned transport companies or – less frequently – for operations carried out by public bodies (internal operators).

All concepts – no competition, competition *in* the market and competition *for* the market – can partially be applied complementarily or in hybrid forms. Most European countries follow to a certain extent the approach of regulated competition, but modalities vary according to national legislation. Additionally, conditions for railways and other local public transport modes may not be equivalent.

The regulation no. 1370/2007 of the European Parliament and Council governs the possibility of public authorities to award public service contracts for public passenger transport where these services are not profitable (so-called 'public service obligations'). Amongst others, the regulation sets out the circumstances under which direct awarding and awarding to an internal operator is possible, the allowed duration and the mandatory content of public service contracts (European Parliament and Council of the European Union 2007).

2.3.7 Rolling Stock / Fleet of Vehicles

2.3.7.1 Technical compliance

Rolling stock and (road) vehicles are the vessels used to transport passengers. Vehicles of all public transport modes are required to comply with safety requirements that are usually under national competence. Additionally, since existing infrastructure installations generally conform to existing vehicles that remain in operation, new vehicles need to adapt to given infrastructure requirements more often than vice versa.

For buses, the main factors for technical compliance involve:

- Vehicle size according to road conditions (e.g. available space at bus stops and in turning loops)
- Alignment of doors depending on right- or left-hand traffic and bus stop positions (additional legal requirements possible for the access of people with reduced mobility).
- Optionally telematics systems to interact with traffic light systems and / or operating centres.

For railways, the compatibility of rolling stock with infrastructure is of greater complexity and importance. Railway systems have been built in manifold ways and therefore system characteristics vary widely throughout Europe. International standardisation has occurred to a certain extent, for example by the UIC ('union internationale des chemins de fer'), but national differences are still considerable.

In comparison to road vehicles, the following three components lead to a substantial increase in technical compliance requirements for railways:

- The guidance of vehicles by rail (instead of individual, autonomous guidance)
- The formation of trains by coupling multiple vehicles (carriages)
- The operation of trains by means of integrated control systems (instead of driving on sight)

These differences lead undoubtedly to certain benefits for the use of railways as a means of passenger transport, such as capacity, speed and energy efficiency. However, they also result, amongst others, in the following technical compliance requirements for railway rolling stock:

- Gauge width
- Type and transfer of input energy
- Minimum clearance outline along tracks
- Minimum radii of the horizontal track alignment

- Maximum axle loads
- Maximum length of trains (predetermined primarily by the length of platforms and siding tracks)
- Carriage access installations (predetermined by the height of platforms and legal requirements for the needs of people with reduced mobility)
- Train control systems and technical equipment of trains
- Communication systems between train and infrastructure personnel
- Safety and communication equipment among carriages and engine(s) of a train

Moreover, technical approval of railway rolling stock is usually still under national competence and different standards apply in different countries. Therefore, the authorisation for the operation of a railway carriage or engine is issued for one country only in the first instance. Authorisations for operations in other countries are in principle to be carried out separately at the respective foreign authorities. There are, however, some bi- and multilateral treaties on cross-acceptance of certain components of vehicles that have already been authorised in one country.

For a more comprehensive interoperability among all EU countries, the European Railway Agency – an agency of the European Union – drafts the so-called 'Technical Specifications for Interoperability' (TSI), which are implemented by means of directives of the European Parliament and Council (2008b) and overrule national regulations. The scope of the TSI is yet still to be extended and national regulations are expected to remain relevant for further decades at least (Bundesamt für Verkehr 2013). However, a transfer of competences from competences from national agencies to the European Railway Agency, notably for issuing railway vehicle authorisations, has been envisaged for the upcoming fourth railway package of the European Union (European Commission 2013).

The requirements for technical compliance for metro, light rapid transit and tramway modes range between the two extremes of bus and heavy rail. However, as these vehicles are usually statically assigned to a clearly defined local or regional network, treaties of cross-acceptance or of international standardisation that would be of general significance (i.e. valid not just for single networks) do not exist for these modes so far.

2.3.7.2 Dimensioning

The right dimensioning of rolling stock is relevant in regard to the provision of the appropriate passenger capacity and to meeting the comfort expectations of passengers. Additionally, operational reliability is also dependent on well-dimensioned vehicles, since, for example, undersized doors can prolong the necessary dwell time at stations and stops.

The determining of vehicle dimensions is additionally complicated by the fact that they will remain in operation for up to several decades (cf. Table 2-8) and passenger requirements may change qualitatively and quantitatively. Also, short-term alterations in demand levels, as a function both of weekday / daytime and of the route (section) operated, are a general phenomenon that needs to be taken into consideration.

Table 2-8: Approximate Lifespan of Rolling Stock / Vehicles of Different Modes

Bus (urban; diesel, hybrid or gas)	12-15 years
Trolleybus	20-25 years
Tramway	30-45 years
Heavy Rail (conventional)	35-50 years
Heavy Rail (high speed)	30-45 years

Based on: Lacôte (1992); Glünkin and Turcati (1993); Gierga et al. (1998); Infras (2008); SNCB Corporate Communication (2008); Kanton Basel-Stadt (2013).

2.3.7.3 Investment and ownership

Generally, the provision of rolling stock is in the responsibility of transport operator companies, who may procure, own and maintain the vehicles by themselves.

However, as public service contracts are subject to competitive tendering more often, and since contracts are usually of shorter duration than the lifespan of vehicles, the ownership of vehicles may be connected with a risk of abnormal, early depreciation and may therefore be unattractive for transport operator companies (cf. vehicle lifetime in Table 2-8). Moreover, the necessity to own proper vehicles could hinder companies that are new in the market from prevailing against incumbent transport operators, even though this kind of competition is particularly aimed at by the introduction of competitive tendering. Therefore, the following two alternative models are applied in different places in Europe:

- State ownership: Rolling stock can be procured and maintained by state bodies, but transferred to transport operator companies for the performance of their contracted services.
- Leasing: Rolling stock and vehicles may be owned by private third parties (in the UK so-called ‘Rolling Stock Companies’, ROSCOs) that own the rolling stock and rent or lease it to transport operator companies.

2.3.8 Infrastructures

2.3.8.1 Construction

The construction of new infrastructures can be initiated, and financed, by both public and private bodies (including transport companies). Private bodies are usually only involved in the following two cases:

(a) If the investor is able to operate transport services on the new infrastructure by himself, and if the profitability prospects are sufficiently high to cover the investment costs (including risk-associated costs).
(b) If the investor is able to levy a toll or fee for users of the new infrastructure which prospectively compensates his investments costs (including risk-associated costs).

The period in which the investor is able to control operations or levy a toll can be of limited duration. Often – such as in many public-private partnerships (PPP) –, infrastructures become public (i.e. state, commune etc.) property after a defined period. It is, however, at the risk of the investor, whether the infrastructure actually pays off its investment and maintenance costs within this this period (usually several decades). On the other hand, private investors may be able to make considerable profits with PPP, which would otherwise have been for the benefit of public bodies.

The incentives for public bodies to invest in transport infrastructures are usually similar as it is the case for private investors. The only difference is that public bodies not only consider financial returns on investment, but also wider economic benefits. Positive regional (economic) effects therefore allow public bodies to make investments which would not be viable for private investors. Furthermore, a shortage of public finance at the time of investment may force public bodies waive their own investment to privates, even if the financial profitability is undoubted.

2.3.8.2 Maintenance

The maintenance of public transport infrastructure is generally in the responsibility of the owner of the infrastructure.

Roads and bus stations are most often in state ownership, but may also be privately owned (e.g. PPP). This is also the case for rail infrastructures, even though they can also be in direct ownership of (integrated) railway companies or transport infrastructure companies (the latter case becoming more frequent with the ongoing separation of rail infrastructure and operations as advocated by EU legislation).

Both inspection and repair, which constitute the two main pillars of maintenance, can be carried out directly by the owner, but they alternatively may also be outsourced to third parties.

Maintenance costs can be financed by fees or tolls at the expense of the users, i.e. transport operator companies (that pass the charge on to their passengers). Should this financial revenue be insufficient – as it is the case for most regional and local roads and rail lines –, and should

the infrastructure be of structural importance or otherwise to be provided by the state, public bodies can decide to subsidise or fully bear maintenance costs.

2.3.8.3 Use

The use of infrastructures by transport operator companies usually incurs a financial contribution to the owner for maintenance and depreciation costs. The relationship between owner and user usually follows one of the following models:

(a) The owner provides the infrastructure to everybody for free (e.g. local roads)
(b) The owner provides the infrastructure to everybody by levying a toll (e.g. toll roads, railways with 'open access')
(c) The owner provides the infrastructure only upon agreement or contract (e.g. service contract, franchise, public service obligation) that may include the right of exclusive use of the infrastructure, but also financial contributions and other conditions in regard to the services to be carried out (e.g. bus stations, tramway networks etc.)
(d) The owner does not provide the infrastructure to others, but operates transport services by himself (e.g. integrated railway company)

2.3.9 Fares

2.3.9.1 Introduction

Public transport fares are the financial contributions of passengers to transport operator companies in order to make use of their transport services. Together with possible payments by public bodies, they should cover expenses for public transport operation and infrastructure (cf. 2.3.6).

The sale of a fare leads to a contract of carriage between the passenger(s) and the transport operator company (or companies). The range of these fares (single / multiple tickets, travelcards, reductions etc.) and the price level can in principle be determined by the transport operator company, but they often need to meet tariff provisions set out by the transport authorities (e.g. max. price level, concessionary fares).

Fares are in many countries subject to value added tax, but tax rates and tax exclusion provisions vary widely between European states.

While transport operator companies are generally responsible for their own sales and revenues, the need for passengers to pay fares for each transport stage separately can be deterrent. Therefore, in many urban areas and also throughout larger regions, contracts between different providers of public transport services have been concluded in order to simplify the fare systems for passengers. Transport associations (cf. 2.3.5) can assume an important role in this regard. The following three levels of tariff cooperation can be distinguished: single tariff; through tariff; common zonal tariff.

2.3.9.2 Single tariff

To use public transport services with single tariff, it is necessary to acquire fares separately for specific transport operator companies.

For transport operators, the use of a single tariff is advantageous for three reasons:

(a) Coordination with other transport operators on fares, sales and revenue is not necessary
(b) The fare autonomy fully remains in the hands of the company operating the transport services (apart from provisions by transport authorities)
(c) Prices can more directly reflect the expenditure for the provision of the used transport service

On the other hand, for passengers, single tariffs are disadvantageous for two other reasons:

(a) In case of interchange(s) to other transport operators, passengers need to buy multiple tickets, each from a separate place of distribution.
(b) Since most transport operators determine the price of their fares either degressively according to the distance travelled or with flat rates, each interchange has an increasing effect on the total price for all fares

For these reasons, single tariffs remain today mainly on public transport services that operate at a price level deliberately above or below the average price level (boats, cable cars, touristic services etc.), but also on few other transport services for which operators do not want to renounce the above-mentioned advantages (e.g. no-frills services, special offers).

2.3.9.3 Through tariff

Through tariffs maintain almost all advantages of single tariffs for transport operators, but are much more attractive for customers:

Passengers can buy interchange tickets that are valid on several transport operator companies' services. Additionally, in certain cases, passengers can even benefit from degressive distance-based fare rates that cover the entire journey or other discounts.

Transport operators, for their part, need a certain amount of coordination to determine the range and price of fares that are jointly distributed. They remain, however, autonomous on the pricing of their fares (apart from previsions set out by transport authorities), since the distribution of revenues of interchange tickets has been agreed beforehand.

Through tariffs are frequent on transport services that are operated jointly by different transport operator companies, but also on various services that offer direct connections to other services (e.g. 'PLUSBUS' in the UK, 'Direkter Verkehr' and 'Inter-Abonnement' in Switzerland)

2.3.9.4 Common zonal tariff

A common zonal tariff area consists of a number of spatially clearly defined zones. Within this area, fare prices are calculated only according to the number of zones that are crossed in the course of the journey (and the normal discounts for certain user groups). Passengers have

the free choice between all available means and routes of transport and can freely interchange among them within the chosen zones. Financial incentives in favour of certain routes and connections no longer exist.

Thus, if clearly structured and communicated, the common zonal tariff has the potential to considerably simplify the fare systems in areas of dense public transport networks. If the zonal system can be straightforwardly and clearly communicated to customers, it can contribute to the ease of use of local public transport.

The introduction of such tariff areas has often been stipulated by transport authorities, and where they exist, the recognition of this tariff by transport operators is usually a prerequisite for subsidies or even for licences to offer public transport services (Knieps 2004).

The consequences for transport operators are the following:

(a) The operators' fare autonomy needs to be renounced. Pricing can only to a limited extent reflect the actual expenditure of transport operator companies, and price competition is no longer possible (as it would be desired in deregulated markets). The actual amount of revenues is often somewhat uncertain beforehand, as it is calculated according to a scheme of distribution based on a predetermined formula considering passenger-km and the number of passengers. This data are usually extrapolated from passenger counts that should be as representative as possible. The modalities of these passenger counts and the weighting of passenger-km and the number of passengers can be very controversial among transport operator companies.

(b) Losses in revenue are usually inevitable. Knieps (2004) distinguishes three different effects:

   (i) Harmonising effects
   Effects arising from the need to adopt a common price level for all transport operator companies: In most cases, it is inopportune to adjust prices to medium or expensive former tariffs. Instead, the common price level often follows the cheapest of previous tariffs, so as to prevent disadvantageous price effects for existing customers and attract new ones.

   (ii) Through tariff effects
   Effects arising from the combination of several trip stages to one through fare. No revenues are generated for local connections within a zone, where the fare has already been used for another connection (e.g. train from zone 1 to 2; connecting bus within zone 2 can now be used at no charge). The degressive zone-based fare prices can lead to additional losses.

   (iii) Coordination losses
   Expenditure for coordination among and between transport operator companies and transport authorities, and for determining revenue distribution schemes.

Since transport authorities may require transport operator companies to adopt the common zonal tariff, the incurred expenditure and consequential losses can be compensated as a

'public service obligation' according to the EC regulation 1370/2007 (Otting and Olgemöller 2009).

Common zonal tariffs are usually administered by transport associations with a central office. These transport associations can vary in the following points:

(a) Associates of the transport association: transport operator companies, transport authorities, or both. Roles of the involved stakeholders.
(b) Additional responsibilities (e.g. service contracting and subsidies on behalf of transport authorities; marketing, sales, timetable coordination, quality management, customer services etc.)
(c) Range of fares covered by the common zonal tariff (all users and fares vs. farecards only, local journeys only; availability of day tickets, return tickets and other special offers)
(d) Modalities of calculating the scheme of distribution of revenues among participating transport operator companies

Common zonal tariffs have been introduced for local public transport in many European conurbations, with varying frequency in different countries. In the U.K. outside of London, for example, this system is not reconcilable with deregulated public transport markets. Zonal tariffs that apply on individual companies only are not to be confused with common zonal tariffs, but should be considered as single tariffs (cf. 2.3.9.2).

2.3.10 Personnel and Customers

2.3.10.1 Introduction

Personnel and customers are the human part of public transport and are therefore of considerable complexity. In the context of this chapter, the focus will be on the human being both as an indispensable element for the functioning of public transport, and as the target element, which public transport should be geared at.

2.3.10.2 Personnel

Public transport personnel comprises the following four sectors:

- Driving personnel
- Infrastructure and operations personnel
- Personnel with customer interaction (on board and stationary)
- Management and administration

In special cases, members of personnel can also be entrusted with tasks of more than one sector (e.g. driving personnel with customer interaction, such as ticket sales). Generally, however, public transport personnel must be comprehensively trained. Specific knowledge, skills and licences are a prerequisite for most jobs in public transportation.

Most employees are thus highly specialised to their duties and their area of responsibility. Also, staff trainings are not standardised but differ according to company profiles and to legal

and regulatory requirements at national level. Therefore, interchangeability among personnel with different responsibilities or of separate operational areas is very limited.

The relationship between employees and employers is governed by contracts, in some cases by collective labour agreements. In this regard, and especially in large, (formerly) state-owned companies trade unions play an active role. In addition to different company backgrounds, this circumstance has contributed to significant differences in the rights and duties of employees.

2.3.10.3 Customers

Customers are the raison d'être for local public transport. The transport offer and the infrastructure should by all means be geared to meet the needs of (potential) customers.

Meeting the needs of passengers is of special importance if public transport should also carry choice riders, and achieve a modal shift. Choice riders always have other mode(s) of transport at their disposal, and can always compare between them. It is the quality of public transport that should attract customers and make them renounce other travel alternatives.

However, the expectations towards the quality of public transport are not uniform among different groups of (potential) customers: Young vs. elderly passengers, frequent vs. rare passengers, business vs. leisure passengers, prosperous vs. deprived passengers, to mention only few of the manifold differences.

Indeed, describing the quality of public passenger transport is not obvious, and for this purpose, the European Standard EN 13816 (European Committee for Standardization 2002) has been formulated. It contains the following quality criteria:

- Availability
- Accessibility
- Information
- Time
- Customer care
- Comfort
- Security
- Environmental impact

The sensitivity of passengers to certain service elements can be observed, especially where quantitative measurements are possible. A range of empirical values is summarised in Table 2-9.

Table 2-9: Sensitivities to Service Elements of Public Transport (Germany / Switzerland)

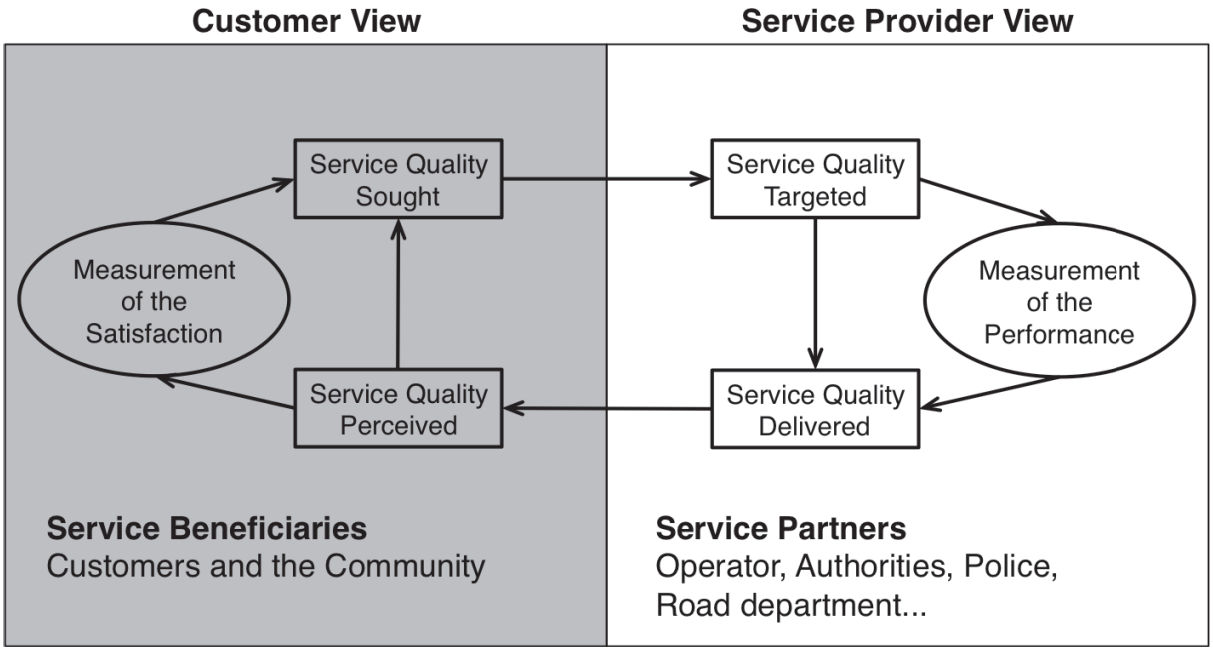
Accessibility	Longer walks are weighted much stronger than shorter ones: 5 minutes walk are perceived as 8 minutes travel time, whereas 12 minutes walk correspond to more than 30 minutes travel time.
Availability	Waiting times are weighted 1.3 times longer than the actual amount of travel time
Frequency	The effect of the quantity of services (vehicle km) on demand can be described with an elasticity of 0.25 to 0.35
Transport Speed	The effect of public transport travel time on public transport demand can be described with an elasticity of -0.6 to -1.0**
	The effect of private transport speed on public transport demand can be described with an elasticity of -0.7 to -1.0*
Direct connections	The need to change instead of a direct connection can reduce demand by up to 40%; interchanges close to origin or destination are weighted to a lesser extent
Reliability	Arrival delays are perceived 2.7 times longer than the actual amount of travel time
Comfort	*(No quantitative observations)*
Fares	The effect of fares on public transport demand can be described with an elasticity of -0.2 to -0.3* (-0.25 to -0.40**)
Distribution	*(No quantitative observations)*
Information	*(No quantitative observations)*
Publicity	*(No quantitative observations)*
*value for urban transport / **value for inter-urban transport	

Sources: Vrtic et al. (2000); Birn and Schäfer (2008); Weidmann (2013)

Attaining high levels of service quality can surely not be achieved by deregulation and competition only, but this development has at least lead to a certain degree of consciousness and considerations about service quality (Meier et al. 2009).

Meeting the needs also means meeting the expectations of customers towards public transport. However, as stated earlier, these expectations vary widely. Therefore, the standard EN 13816 considers customer satisfaction not as a static reference, but as the difference between perceived and expected service quality (as shown in the quality loop, Figure 2-5).

Figure 2-5: The Quality Loop



Source: Standard EN 13816 (European Committee for Standardization 2002)

This is where the consideration of psychological aspects becomes of importance. A high-quality service does not necessarily have to be perceived by its customers as such, whereas the perception of poor services may be considerably improved by adjusting some details. Moreover, the subjective perception of the service may again be different from how it is remembered retrospectively.

In this regard, Dziekan (2008b) states that while memory representation of public transport use is usually pessimistic (i.e. the actual service quality is often underestimated), the following three elements for the cognition of public transport are of special importance to enhance its ease-of-use: visibility, straight route layout and labelling. More concretely, this involves, amongst others, supporting the travellers' cognitive map by providing to-scale maps (for the misleading effect of distorted and over-simplified maps see Guo (2011)) and the provision of static *and* dynamic travel information, whereby design and layout should follow "cognitive ergonomic guidelines", such as standardised representation of information (Dziekan and Dicke-Ogenia 2010).

The frequently mentioned 'mentality differences' that unconsciously influence the mode choice process according to regional customs and habits – which can easily be used as a pretext to explain a low modal share of public transport – has been estimated by Haefeli (2008) to be of negligible significance in practice. Rather, he observed in his different case studies a constant positive effect from the actual offer of public transport on its image and its utilisation.

Apart from the choice whether or not to use local public transport, customers and potential customers can express their wishes and needs that may or may not have been met, directly to

public transport operators or to transport authorities. Additionally, public transport users, as well as non-users, can also influence the offer of public transport indirectly via political representatives as superiors of transport authorities and budget representatives. The way these can be approached depends on the political system; voting politicians in or out can be seen as a final means of exerting influence in this regard.

Both operators and authorities should be interested in receiving feedback, as they are usually commissioned to implement attractive public transport services and to contribute towards a modal shift. They may even carry out surveys within their area of responsibility in order to obtain a more representative image of customer satisfaction.

In some cases, passenger associations form – often consisting of attentive and committed passengers – with the goal of achieving a central and (more) coordinated means of communication between public transport passengers and responsibles.

2.4 Historical Development of Cross-Border Local Public Transport

2.4.1 Introduction

This chapter aims at giving an insight into the historic stages of development of urban public transport. It is not meant to be exhaustive; it should rather identify typical trends and factors, and illustrate consequences. By appreciating the context of the past, certain patterns of current developments may be recognised and better understood. The chapter concentrates spatially on France, Switzerland and Germany as well as their neighbouring countries.

2.4.2 Before 1914

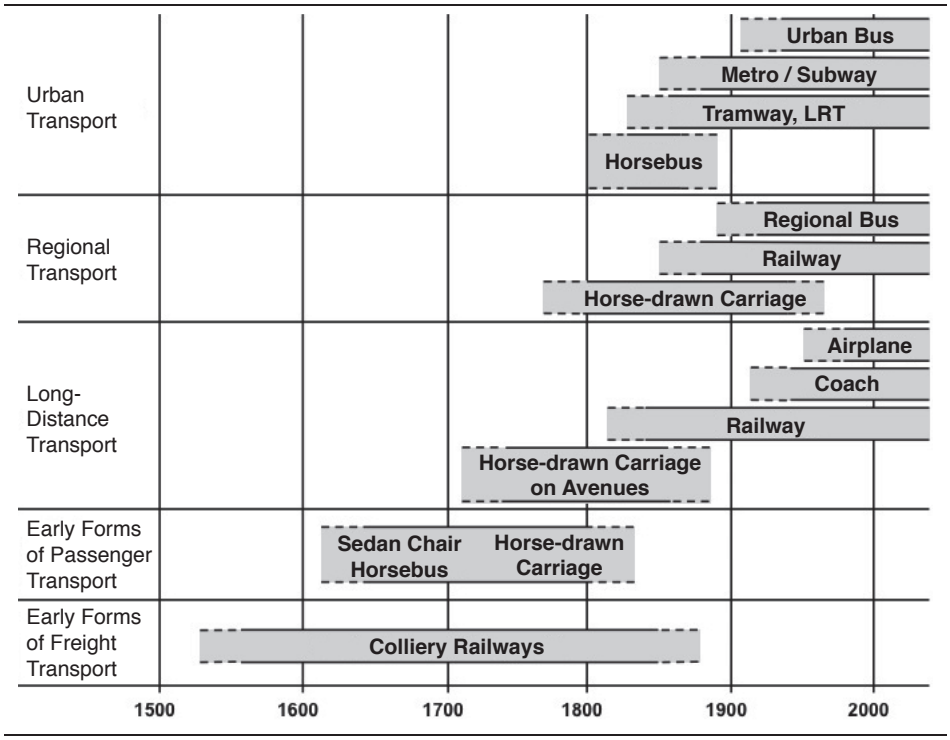
2.4.2.1 General Development

Transportation services had already existed long before industrialisation, such as regular and well-organised horse-powered transport services in the Roman Empire called 'cursus publicus' (Bender 1978). These transport services, however, are in various aspects not comparable to the meaning of public transport at the present time.

The first system corresponding to today's understanding of urban public transport (cf. definition in 2.1.3) was probably the 17th century 'carosses à cinq sols' in Paris that was based on the idea of Blaise Pascal and existed for around two decades. It consisted of five defined lines that were operated with horsebuses at a regular interval of 7.5 minutes during the entire day and at a fixed price of 5 Sols per person (Martin 1894). Generally, however, urban and local public transport started developing in the course of the 19th century.

While the first steam engines and railways have been introduced for industrial usage, it was soon clear that they can also be used as an efficient and rapid means of passenger transportation. Steam-powered passenger railways have been built from the 1830s, although these huge investments were often also motivated by the expected freight volumes. First passenger services were of (inter)regional nature, but soon – as the different networks have grown and been linked – long-distance services were introduced. Such passenger services have spread all over Europe in the following decades.

Figure 2-6: The Evolution of Public Transport in Europe



Source: Weidmann (2013)

As for local and (sub-)urban use, streetcars, tramways have been introduced little later, superseding horsebuses. At first, they were still based on horsepower, taking advantage of the low resistance between steel rails and metal wheels (as opposed to unpaved roads). Following the example of railways, few tramways have used small steam engines, but their real success came with electrification towards the end of the 19th century. The more productive and efficient operations lead to most tramways being converted to electric propulsion around the turn of the century, and many more being built at that time. In bigger cities, this also applied to underground (metro) lines.

Operations of tramway lines generally had to be economical, and fares were therefore clearly above today's price levels. Initial routes usually followed the highest potential demand; they often connected important centres, or city centres to surrounding villages. Little later, tramways were also recognised as an important means of land use and housing development. Therefore, new, strategic lines started to serve emerging areas, even though they may not have been profitable from the beginning. In such cases, investors or public bodies had to contribute to construction and operating costs from the beginning (Appenzeller and Gosteli 1995).

2.4.2.2 Cross-Border Development

While many of the initial railway lines mainly served national markets, cross-border connections were added little later, especially where (economic) interrelations to neighbouring borderlands existed. The pace at which they were implemented was comparable to other, domestic lines (for an overview, see Table 2-10). To erect the border-crossing links, agreements between the involved states and authorities on construction and operation modalities were necessary. However, at this time, international borders in Europe could generally be crossed without passports, which made it much easier to travel across borders. Only the import and export of certain goods was subject to customs declaration, and some states also imposed regulations on work migration (Appenzeller and Gosteli 1995; Löfgren 1999). Thus, the implementation of such cross-border projects was probably of lesser complexity than it is nowadays (Appenzeller 2013). This is certainly a reason for the sometimes extremely small amount of time required for the construction of infrastructures at this time.

However, some obstacles still had to be overcome. Customs arrangements and installations were to be prepared, and concerns of local populations to be mitigated (such as, in the case of Basel in the 1840s, the fear of workforce competition and Catholicism from France) (Stoskopf 2013). Further complications included the use of different technical (national) standards (e.g. rail gauge), or non-uniform time references (e.g. around 20 minutes difference between Switzerland and France before the adoption of the Central European Time zone in 1894 and 1940 respectively) (Appenzeller 2013).

Interestingly, railways of the (nationally) peripheral regions Alsace (France) and Vorarlberg (Austria), both initiated on a private basis, were first connected to surrounding borderlands, whereas national connections towards Paris and Vienna were opened several years later.

A special burden to cross-border links were times with military activities. The cross-border railway bridge Straßburg–Kehl, for example, after having been formally opened in 1861, was partially destroyed in 1870 following the events of the Franco-German War and was subsequently rebuilt as a domestic German bridge. Interestingly, in the First World War (1914-1918) the bridge remained undamaged, since the borderline was moved back to this place only at the end of this war and thus no military actions happened in this domestic area (Forthoffer and Ribeill 2011).

Tramways, for their part, were always of local and (sub-)urban use, and were built as uniform systems. Therefore, the implementation of cross-border connections was a natural consequence of cross-border interactions, where they existed at the local scale. Border controls were a standard procedure, even though they sometimes involved the need for passengers to get off during customs checks, or even to change to another (connecting) vehicle. A list of prominent examples of cross-border tramways is given in Table 2-11.

Of course, also buses started to be used as a means of cross-border public transport, especially where no rail infrastructure had been built so far. An early local cross-border bus line

operated in 1914 from Horbach (Germany, near Aachen) to Heerlen (Netherlands), but was suspended in the same year due to the outbreak of the First World War (Bimmermann 1999).

Table 2-10: Prominent Examples of Early Cross-Border Railway Links

Opening	Connection	Countries	Type at opening	Source
1842	Tourcoing–Mouscron & Valenciennes–Mons	France, Belgium	Steam railway	Duplessy and Landoy (1845)
1843	Verviers–Aachen	Belgium, Germany	Steam railway	Duplessy and Landoy (1845)
1844	(Strasbourg–) St-Louis–Basel	France, Switzerland	Steam railway	Stoskopf (2013)
1852	(Metz–)Forbach–Saarbrücken	France, Germany	Steam railway	Neu (1994)
1855	(Freiburg–) Haltingen–Basel	Germany, Switzerland	Double track steam railway	Wägli (2010)
1856	Basel–Säckingen	Germany, Switzerland	Steam railway	Wägli (2010)
1858	(Seyssel–) Bellegarde–Genève	France, Switzerland	Double track steam railway	Wägli (2010)
1860	Salzburg–Traunstein (–München)	Germany, Austria	Steam Railway	Bufe (1995)
1861	Strasbourg–Kehl	France, Germany	Steam railway	Forthoffer and Ribeill (2011)
1864	Bayonne–Hendaye–Irun–San Sebastian	France, Spain	Steam railway at diff. gauges	Vergez-Larrouy (1995)
1868 [1872]	Nice–Monaco [–Ventimiglia]	France, Monaco, [Italy]	Steam railway	Chaintreau et al. (1993)
1882	St. Margrethen–Bregenz–Lindau	Switzerland, Austria, Germany	Steam Railway	Wägli (2010)
1888	Genève-Eaux-Vives–Annemasse	France, Switzerland	Steam railway	Billiez (1988)

Table 2-11: Prominent Examples of Early Cross-Border Tramway Links

Opening	Connection	Countries	Type at opening	Closure (final)	Source
1883	Genève–Annemasse	Switzerland, France	Steam Tramway	1958	Primatesta (2005)
1887	Genève–St-Julien	Switzerland, France	Steam Tramway	1938	Primatesta (2005)
1889	Aachen–Vaals	Germany, Netherlands	Horse Tramway	1939	Bimmermann (1999)
1889	Genève–Ferney	Switzerland, France	Steam Tramway	1938	Primatesta (2005)
1891	Genève–Douvaine	Switzerland, France	Steam Tramway	1930	Primatesta (2005)
1891	(Genève–)Veyrier–Gare du Salève	Switzerland, France	Steam Tramway	1936	Wägli (2010)
1900	Basel–St. Ludwig [St-Louis]	Switzerland, Germany [France after 1919]	Electric Tramway	1957	Appenzeller and Gosteli (1995)
1906	(Aachen–) Linzenshäuschen –Eupen / –Raeren	Germany [and Belgium after 1919]	Electric Tramway	1944	Bimmermann and Reimann (2011)
1907	Aachen–Altenberg [Kelmis]	Germany [and Belgium after 1919]	Electric Tramway	1944	Bimmermann (1999)
1908	(Carouge–) Croix-de-Rozon–Collonges-sous-Salève	Switzerland, France	Electric Tramway	1939	Wägli (2010)
1910	Basel–Hüningen [Huningue]	Switzerland, Germany [France after 1919]	Electric Tramway	1961	Appenzeller and Gosteli (1995)
1919	(Basel–)Riehen–Lörrach	Switzerland, Germany	Electric Tramway	1967	Appenzeller and Gosteli (1995)

2.4.3 1914-1939

2.4.3.1 General Development

In the period between the World Wars, two important technical novelties in the public transport sector, which had already appeared before the First World War, became more prevalent: buses (as a competing means to tramways) and the electrification of heavy rail lines (that was previously possible on local lines only).

The upcoming of buses meant that they could be deployed complementarily to tramways, so as to serve places not yet connected to rail infrastructure. Yet, they could also be used as a competing means of transport, taking over market shares from tramways. Especially for suburban lines, this lead to a first wave of tramway line closures in favour of bus services (cf. Table 2-11). In urban areas, the electrically propelled trolleybus revealed in the 1930s to be a flexible, space-saving and economical alternative to tramway lines with low to medium demand levels, especially where the infrastructure was in need of repair (Appenzeller and Gosteli 1995).

To maintain services on the more problematical lines, some loss making tramway companies were granted deficit guarantees by communes or other public bodies, and to the same end, the latter sometimes assumed the responsibility (and costs) for maintenance of infrastructure (Primatesta 2005; Primatesta and Mast 2007).

For railways, technical progress made it possible to run electric locomotives not only on direct current – which is suitable especially for short distances –, but also on alternating current, allowing for much more efficient operations also on main lines. The convincing advantages of alternate current systems led to the start of an extensive electrification development.

However, this did not mean that a uniform electricity system would have been installed on all lines, but instead, different railway companies applied their own levels of voltage and frequency. Additionally, the speed and priority devoted to the electrification process varied from line to line, as the possibility for this investment to both infrastructure and locomotives was not given in all cases. Many lines – especially branch lines and networks of secondary importance with comparatively low transport volumes – are still not electrified today.

2.4.3.2 Cross-Border Development

The First World War was a first big break to the emerging cross-border public transport sector in Europe. During the war, many borders were closed, and only few cross-border public transport services could maintain their operation. In these cases, services on either side of the border had to be separated, and each part operated by personnel of the respective countries (Appenzeller and Gosteli 1995). Moreover, all cross-border infrastructure projects were stopped, and some of the existing infrastructure was damaged during the war.

After 1918, cross-border operations could gradually resume on many lines, even though this was more complicated in certain cases, especially if the concerned route was directly affected by the new geopolitical situation resulting from the end of the First World War.

The tramway line Straßburg–Kehl, for example, having been opened in 1898, was operated as a domestic line in Germany (Blaesius and Gérard 1994). Owing to the new French-German border between Strasbourg and Kehl after the First World War, the existing tramway networks on either side of the border were split and made independent from each other, and operations on the cross-border link were no longer active (Frenz 1980).

The situation of the emergence of a new border also occurred in the Aachen / Eupen area (Germany / Belgium), where operations of previously domestic lines were divided between German and Belgian companies. The continuation of services across the new borders – partly with the new need of changing vehicles and buying separate tickets at border crossings – was only possible after long and tough negotiations between the involved parties on the German and Belgian side (Bimmermann 1999).

An additional incentive for separating operations after the First World War were the variations between countries in their economic situations. By leaving these responsibilities in each country, ticket fares and staff salaries could be adjusted to the respective price and wage levels that sometimes clearly differed (Appenzeller and Gosteli 1995). On the other hand, these economic differences also served as an inducing effect for cross-border traffic.

For railways, the electrification of existing railway lines that started soon after the First World War was a gradual process. The order in which railway lines were equipped with catenary equipment was a direct reflection of the strategic importance being allocated to these lines. Consequently, cross-border sections have not always been treated primarily.

At this time, after new borders having been created and technical progress advancing, the ‘Union Internationale des Chemins de Fer’ (UIC) has been founded, with the aim of standardising technical and operational specifications of the manifold railway operator companies throughout Europe and Asia. The UIC still exists nowadays and acts as an important platform for a coordinated development of railways worldwide.

2.4.4 1939-1970

2.4.4.1 General Development

During the Second World War (1939-45), public transport operations were widely limited due to a lack of (human) resources. Also, fuel shortages often lead to a strong focus on electric propulsion. In urban areas, this resulted in a concentration on main lines and service reductions, and a relatively high utilisation of those services still being offered.

After the war, efforts were made to recover normal traffic conditions as quickly as possible. In some cases, this simply meant that previous service offers were re-established, but it was often accompanied by new, innovative developments: The emergence of the automobile as a modern and prestigious means of transport lead to a rapid change in the significance of urban public transport.

The central postulate of this movement consisted in making urban traffic more fluent, faster and safer. This should be achieved, amongst others, by a consequent separation of transport

modes, so that tramways, cars and pedestrians can move freely and safely on their dedicated lanes. Not only did this mean a re-distribution of street space to the different transport modes, but it also involved a widening of areas for traffic in general. Especially narrow streets in central urban areas were to be broadened in order to make transport flows more fluent.

In a subsequent phase, the dedicated space for public transport on streets was again questioned: the growing importance of the tertiary sector, new commuter flows, and the progressive mass motorisation – which in turn made it possible to live and work in areas hardly served by public transport – lead to modified usage patterns that were not in favour of public transport (Haefeli 2008).

The image of the tramway as an inflexible means of mass transport (versus the car as a noble, fast and efficient way of travelling), and the decreasing costs for the operation of buses (that can flow together with motorised traffic) lead to the view that removing the space dedicated to tramways would make the entire system more efficient, fluent and safe. Alternatively, where demand justifies, transport modes should be separated vertically, e.g. by elevated urban expressways or underground tram / metro lines (Schmucki 2001).

Important reports, such as ‘Die autogerechte Stadt’ (Reichow 1959) or ‘Traffic in Towns’ (Buchanan 1963) lead to a widespread consent of these principles. It is, however, important to note that these reports did not postulate an absolute supremacy of cars over all other means of transport, but rather a natural coexistence among them (even though bicycles seemed not play an important role). However, as the reports rather focused on new-built cities and did not take into account the limited spatial (and financial) possibilities of grown urban areas, the actual implementation varied widely between cities and almost always differed from the initially proposed concepts (Haefeli 2008).

The consequence for urban public transport was generally a shift from tramways to buses and, at best, the maintenance of services with minimal investments. Railway lines in conurbation areas (as opposed to rural lines with rather low demand), however, were mostly maintained, even though their track alignment was sometimes moved, mostly underground, if it interfered with main roads or other uses.

2.4.4.2 Cross-Border Development

The Second World War lead to a general closure of international borders in Europe. Public transport services across and near borders were widely suspended. Various military actions lead to serious damage to transport infrastructure in affected borderlands.

An exceptional case is to be mentioned with the adjacent tramway networks of the cities of Saarbrücken (Germany) and Forbach (France). While these have been operated separately in times of peace, with their terminus stations within walking distance at either side of the border crossing point ‘Goldene Bremm’, a through service (with a short, new track section between the two networks) was operated during the German occupation of Alsace and Lorraine in the Second World War (Sommerfeld 1979). Thus, it can be said that it was the de facto disappearance of the border which made it possible to realise this service improvement for

some years. Of course, this example does not state anything about the wider political circumstances and motivations at this time.

Another special case consists in the city of Berlin, where a new border emerged following the Second World War. Public transport connections adapted as a consequence of the separation between West and East with a clear emphasis on domestic transport. Further developments clearly differed between the two parts of the city.

After the war, cross-border tramway lines were in many places among the first being removed in favour of bus services, if they have not already been closed during the war (cf. closure dates in Table 2-11, page 47). The process was certainly facilitated by the reluctance of the involved parties at either side of borders to assume responsibility for raising the necessary funds to maintain, renew, and adapt these lines to current requirements.

Cross-border railway lines in urban areas were mostly maintained, since they were often also used for freight and long-distance services. Yet, frequency and speed of local services may well have differed from comparable domestic routes.

2.4.5 1970-Today

2.4.5.1 General Development

From the end of the 1960s, there was a growing awareness that the set goals – especially free flow for motorised private transport – did not eventuate, even after many structural measures implemented in cities. Moreover, the new allocation of urban areas, with a large share reserved for motorised transport, has contributed to a considerable inhospitality of cities at that time.

However, transport habits had changed rapidly in these years and could not be reversed easily. In the Federal Republic of Germany, for example, the modal split of public and private transport changed from 70:30 in 1963 to 30:70 in 1976 (Schmucki 2001).

Menke (1975) succinctly described the vicious circle leading to the decrease in ridership that has been experienced by many urban public transport companies at that time: The increasing motorisation of the population leads to lower demand for public transport; thereby, profitability of public transport decreases, which inevitably triggers higher fares for public transport users. This, in turn, reinforces the trend of renouncing public transport in favour of private transport.

In many cities, it had been realised at this time that a higher efficiency in urban transport can be achieved if both public and private transport systems are promoted, or that public transport should be even more favoured than motorised private transport. The latter position arose mostly in the 1980s, when arguments about the environment, pollution, emissions etc. were added to the discussion.

After a period of generally strong opposition against ‘outdated’ public transport, new investments, prioritisations (e.g. at traffic lights), infrastructures (e.g. underground sections) and even road space were again dedicated to improve urban public transport systems. Also,

urban transport started to be considered as a part of an integrated system, with transport chains that may consist of different modes. This development was accompanied by a re-dimensioning of urban roads (also with a focus on human powered transport), and a reorganisation of the roadside environment according to aesthetic principles (Schmucki 2001).

The success of public transport promotion was not equal in all cities, and depended on the mutual effect of various factors. Haefeli (2008) found exceptionally high growth rates of public transport usage in those places where comprehensive fare reductions were granted by means of public subsidies, whereby the resulting financial losses often eventually turned out to be at a very low level, thanks to the strong effect on demand.

Today, there is a wide consensus throughout Western Europe that public transport is an efficient and inevitable part of urban transport systems. Yet, opinions differ on the degree of public transport prioritisation to the detriment of other modes, notably motorised individual transport. Also, spatial and infrastructural suitability of urban areas for public transport operations as well as the financial resources allocated to this end are of considerable variety throughout Europe.

Therefore, the offer and the usage of local public transport in urban areas, and particularly the modal share of public transport, are still characterised by considerable differences.

2.4.5.2 Cross-Border Development

From the relatively low level of cross-border public transport services at the end of the 1960s, some connections have recovered operations gradually. Yet, the pace of development and the resulting service offer often indicates a lower priority compared to domestic routes. However, a new dynamism has developed with the increasing economic integration, political convergence and legal harmonisation (that have been facilitated by the the European Union and development programmes such as Interreg), and the increasing difficulty of urban roads to take up the resulting increase in cross-border traffic volumes.

In many places, frequencies of cross-border services have been increased, new routes have been introduced (often initially as a test operation, sometimes subsequently converted to a permanent service), and sometimes, even new infrastructures are being built: Two cross-border tramway extensions are due to open in the near future: A line from Basel (Switzerland) to Weil am Rhein (Germany), and another one from Strasbourg (France) to Kehl (Germany) across the Rhine (Rosenberger et al. 2010).

On the other hand, there is still a strong tendency to the national perspective and the various organisational differences for public transport as described in chapter 2.3 are still present. Conversely, these differences appear not to decrease, but rather increase, such as growing bureaucratic requirements or growing nationalistic movements as a counter-reaction to cross-border integration. Thus, even though much effort is being taken to overcome border-related obstacles and improve cross-border networks, the necessary amount of this effort is likely to remain at a high level or might increase even further in the future.

2.5 Literature Synthesis

2.5.1 Border Effect on Public Transport Framework Conditions

2.5.1.1 Findings

A central point following from the literature is that borders cannot be regarded as a uniform element exerting a standardised influence on neighbouring regions: On one side, boundaries have different functions (that may or may not coincide at international borderlines), and these functions can be of varying intensity. This is most evident when comparing, for example, internal EU borders that do not fall together with linguistic boundaries with borders at the periphery of the EU: While both are regarded as 'international borders', they are clearly of very different nature.

Moreover, the properties of borders are always subject to substantial variation over time: Borders may be moved, opened and closed, and borderlands may change from transboundary contact zones to national defence areas and vice versa. The development of borders and borderlands is always subject to the relations between the concerned nation states. Therefore, cross-border activities – which often involve niche business areas – are typically characterised by strong external influences, lower planning security and a complicated legal framework.

For cross-border local public transport, this means that an adaptation to the specific local conditions is necessary in each case. Laws, regulations and organisational structures are usually not targeted at this special type of public transport, and appropriate solutions have to be found on a case-by-case basis.

2.5.1.2 Open Points regarding the Central Research Question

It has been suggested by the literature that differences in land use and transport facilities on either side of the border may impede the development of efficient local public transport systems. However, this effect has not yet been analysed in detail or quantitatively, even though it could potentially be of important significance.

2.5.2 Border Effect on Demand for Public Transport

2.5.2.1 Findings

The influence of international borders on the demand for public transport services is twofold:

(a) It may impact the demand potential – for all modes – between neighbouring borderlands: Both demand-inducing and demand-reducing effects can be observed.
(b) It may influence the behaviour, notably mode choice, of individuals travelling across borders into foreign areas.

Both effects depend on local and regional circumstances, and they always apply simultaneously, making it very difficult to disentangle the different factors and effects, and to put them on a general basis.

2.5.2.2 Open Points regarding the Central Research Question

Certain studies have observed and measured the overall effect of borders on cross-border transport volumes. However, they could not reveal the determinants of the different border effects that lead to this overall effect. A more detailed analysis on differences in demand structure, such as personal characteristics of passengers, their trip purposes, needs and expectations may reveal additional findings, which would also be of interest with regard to the central research question of this study.

2.5.3 Border Effect on the Provision of Public Transport

2.5.3.1 Findings

The amount of administrative efforts required for providing cross-border public transport has been identified to be clearly higher than for domestic public transport. Additionally, planning security across borders is lower than in domestic cases.

These complicating elements for the provision of public transport across international borders can be met by locating common interests, and particularly, cooperation across borders. This need for cooperation applies for all parties involved in providing public transport, both on strategic and operative levels. The most important ones thereof are:

- Politics: addressing the issue of cross-border local public transport and finding common grounds and goals beyond borders
- Authorities: finding good partners across borders and creating the right modalities to allow an uncomplicated implementation and an effective development of cross-border public transport (authorisations, planning, financing, tendering)
- Transport operators and associations: integrating cross-border services into existing domestic transport systems (fares, connections, information etc.)

2.5.3.2 Open Points regarding the Central Research Question

As a result of the identified obstacles, but possibly also due to a border-related cognitive bias, cross-border public transport relations may appear less attractive to customers, as compared the domestic public transport offer. While this may be objectively justifiable in some cases, it might as well be a subjective impression. Comprehensive comparisons of perceived and real quality of domestic and cross-border local public transport services do not exist so far.

Moreover, the identification of a set of basic principles to tackle the specific challenges of providing cross-border local public transport – notwithstanding the heterogeneity of cross-border agglomerations – would be an additional contribution to the existing literature.

3 Research Interests

3.1 Framework Conditions

As shown in the literature synthesis, framework conditions of cross-border agglomerations are characterised by individual cases, rather than by general rules. This applies especially for legal and regulative frameworks; their detailed analysis would go beyond the realm of this work, as this topic has already been researched elsewhere (Gutt 1999; Denert et al. 2006; Wachinger 2006; Vickermann 2008; Zellweger 2008; Tschudi et al. 2014).

However, spatial and technical framework conditions that are relevant for local public transport, and the resulting causal relationships are to be considered in more detail here. Especially the impact of the built environment and infrastructures on public transport could potentially be of importance, but has not yet been sufficiently researched. While these aspects might also be subject to variation from case to case, the lack of existing considerations and findings in these aspects motivates empirical studies.

Therefore, the following research interest has been formulated.

R 1 Are international borders in cross-border agglomerations affected by distinct differences in land use and transport facilities?

Indicators:

- Settlement density
- Spatial coverage of the population by public transport networks

This research interest will be dealt with in chapter 5.1 Topology and Land Use.

3.2 Demand

The structural influence of borders on demand of local public transport can be observed by comparing ridership data of comparable domestic and cross-border relations, including passenger details and trip purposes. Such data has been collected only in single cases, and for existing datasets, comparability is not given by default. The gap of knowledge that could be deduced from this has lead to the next research interest:

R 2 Do demand structures for local cross-border relations differ from domestic ones?

Indicators:

- Overall modal split
- Share of captive riders in public transport
- Mix of trip purposes

This research interest will be dealt with in chapter 5.2 Demand Structure.

Apart from the structural effects of borders on cross-border agglomerations, no clear knowledge exists about the impact on individual behaviour. Yet, it would be of interest to which extent the observed specific characteristics in cross-border demand are a result of decisions and behaviour of individuals, as opposed to structural effects of cross-border environments. In other words, how much do cross-border passengers have the same attitude, needs, expectations and behaviour as domestic passengers? Or are the observed differences rather a result of impersonal, objective factors, which would equally apply in other areas? This leads to the following research interest:

R 3 Are the expectations and needs of passengers the same for domestic and cross-border journeys?

Indicators:

- Passenger satisfaction
- Motivation of passengers to use public transport

This research interest will be dealt with in chapter 5.3 Customer.

3.3 Service Offer

The often comparatively low modal shares and demand levels on cross-border lines might not just arise due to the bare existence of a border, but it could as well be a consequence of a poorer service offer. However, such assumptions cannot be verified nor falsified, as long as comprehensive analyses of the quality and quantity of cross-border services – in comparison to domestic routes – do not exist. This should be addressed in the following research interest:

R 4 Do the characteristics of service elements vary between domestic and cross-border local public transport?

Indicators:

- Speed
- Frequency
- Service Hours

This research interest will be dealt with in chapter 6.1 Organisational Structures.

A similar effect on public transport demand and modal share can be exerted from the fare price level, which makes them worthwhile for closer research. Additionally, given the fact that most urban public transport services are subsidised, fare systems and price levels are also a reflection of the will of public authorities – and sometimes also of transport operator companies – to make services attractive. A comparison of domestic and cross-border fare systems can reveal a great deal and has thus been included in the next research interest:

R 5 Are cross-border journeys affected by more complex fare systems and less attractive price levels that may be caused by incompatibilities of different domestic fare systems?

This research interest will be dealt with in chapter 6.3 Fares.

In addition to the understanding of existing public transport systems, solutions to improve the provision of existing services are just as important. Moreover, it remains the question on the effectiveness and appropriateness of the variety of such solutions and strategies. The following research interest should take account of this:

R 6 Although the characteristics of cross-border agglomerations may vary from one case to another, is it possible to distil a common set of basic strategic principles to tackle the challenges of providing local public transport across borders?

This research interest will be dealt with in chapter 7.2 Fields of Action and Approaches.

4 Methodology

4.1 Overview

The research concept with regard to the main research question and the defined six research interests is based on four pillars (cf Table 4-1):

- Spatial analysis for the research interests of spatial dimension: R 1 and R 4
- A dedicated passenger survey for the research interests that focus on customers of local public transport: R 2 and R 3
- The transformation and standardisation of existing data (which could otherwise not be analysed across borders) as a basis of comparison for the research interests R 1 to R 5
- And the synthesis of own results, existing literature and practical examples for research interest R 6.

Table 4-1: Research Interests and Methodical Pillars

Research Interests	Methodical Pillars	Spatial analysis	Passenger survey	Transforming, standardising existing data	Synthesis of own results and literature
R1	Land use and transport facilities	X		X	
R2	Demand structure		X	X	
R3	Passenger perspective		X	X	
R4	Service elements	X		X	
R5	Fare systems and price levels			X	
R6	Basic strategic principles				X

The following chapters provide more details of of the spatial analysis (chapter 4.2) and the passenger survey (chapter 4.3), including the application of existing data that has been transformed and standardised for combined analysis. Chapter 4.4 provides characteristics of the agglomerations that have been selected as case studies in 2.1.2.5.

4.2 Spatial Analysis

The application of Geographical Information Systems (GIS) in this project (chapter 5.1 and 6.1) aims at analysing the spatial dimension of public transport systems, including the prevailing circumstances (infrastructure networks, settlement structures etc.) as well as the spatial characteristics of the public transport offer itself. The spatial dimension notably allows comparisons between different sections of the analysed areas, or between different types of public transport, which facilitates the examination of given research problems.

A certain extent of fundamental spatial data that served as input data for the spatial analyses had already existed and could in many cases be provided by responsible bodies. These datasets are numbered (a) to (h) and are shown in Table 4-2.

This data, however, was supplied in different formats and with different standards (e.g. projection, classifications, date and method of data collection) and was in a first step converted to a common basis as far as possible. In certain cases, additional spatial data had to be collected or digitised manually. Furthermore, many spatial datasets were complemented by qualitative attributes, resulting in a comprehensive database for spatial analyses. An overview of these dataset transformations named [a] to [f], which have been conducted as a preparation for spatial analyses, is given in Table 4-3.

This table is followed by the notes (1) to (6), which describe the assumptions and procedure descriptions of the transformation processes.

The actual spatial analyses, designated A to E, which have been carried out to obtain new knowledge in the scope of the research interests are listed in Table 4-4.

Generally, these analyses deliberately follow established methods of spatial public transport analysis, so as to enable the results to be compared to other studies. However, what makes the analyses unique is the combination of datasets from various sources: Usually, data are analysed only to the spatial extent that they have been collected; other data may not be directly comparable, may not be available, or may even be not of interest. However, the integration and comparison of different data sources across borders, including the involved challenges, have been put at the heart of the spatial analyses in this study.

Table 4-2: Spatial Input Datasets

Item		Shape	Attributes	Spatial Extent	Sources*
(a)	Topographic maps at different scales	Raster		France, Switzerland and neighbouring borderlands	IGN France, swisstopo
(b)	Communes	Polygon	Population, Area, Population Density	France, Switzerland, Belgium, Upper Rhine (D/F/CH)	IGN France, swisstopo, IGN Bruxelles, SIGRS / GISOR, Swiss Federal Statistical Office, INSEE, STATBEL, Statistisches Landesamt Baden-Württemberg
(c)	Road and railway network	Line		France, Switzerland, Upper Rhine (D/F/CH)	IGN France, swisstopo, SIGRS / GISOR
(d)	Population raster France (200x200m) and Switzerland (100x100m)	Polygon	Population, Area, Population Density	France, Switzerland	INSEE, Swiss Federal Statistical Office
(e)	Public transport stops	Point	Stop name	Switzerland	Federal Office of Transport (Switzerland)
(f)	Buildings	Polygon	Usage type	Landkreis Lörrach	LGL, made available by Landratsamt Lörrach (Vermessung & Geoinformation)
(g)	Public transport timetables and network maps	–	–	Agglomerations of Basel, Geneva, Lille and Strasbourg	Public Transport Operators (on-line publicly available)
(h)	Length of Public Transport Lines	–	–	Agglomerations of Basel and Geneva	Wägli (2010), Annual Reports of Public Transport Companies, missing values calculated with GoogleMaps

* List of abbreviations:

IGN Bruxelles	Institut géographique national (Belgium)
IGN France	National Institute of Geographic and Forest Information (France)
INSEE	National Institute of Statistics and Economic Studies (France)
LGL	Landesamt für Geoinformation und Landesentwicklung Baden-Württemberg
SIGRS / GISOR	Système d'Information Géographique du Rhin Supérieur / Geografisches Informationssystem des Oberrheins (France, Germany, Switzerland)
STATBEL	Direction générale Statistique et Information économique (Belgium)
swisstopo	Federal Office of Topography swisstopo (Switzerland)

Table 4-3: Main Data Transformations

Item		Shape	Attributes	Spatial Extent	Input Datasets	Note
[a]	Agglomeration perimeter	Polygon		Agglomerations of Geneva, Basel, Lille, Strasbourg	(b) communes	(1)
[b]	Agglomeration centre and concentric rings (distance 2.5 km)	Point / Polygon	Distance (radius) from agglomeration centre	Agglomerations of Geneva, Basel, Lille, Strasbourg		(2)
[c]	Local public transport lines	Line	Line number, Route length within perimeter, Journey time per direction	Basel, Geneva	(c) Road and railway network (g) Public transport timetables and network maps k (h) Length of Public Transport Lines [a] Perimeter	(3)
[d]	Population raster Germany	Polygon	Population, Area, Population Density	Basel	(b) Communes, (f) Buildings	(4)
[e]	Public transport stops	Point	Name, mode and ID of stopping lines, number of departures per line (Mon-Fri; Sat; Sun), service duration per line (Mon-Thu), existence of cross-border service (1/0)	Basel, Geneva	(c) Public transport stops (g) Public transport timetables and network maps	(5)
[f]	Catchment areas of public transport stops	Polygon	Same as [e]	Basel, Geneva	[e] Public transport stops	(6)

Notes to Table 4-3: Main Data Transformations

(1) In accordance with the delimitation of the spatial extent of agglomerations in chapter 2.1.2.6.

(2) Determination of the agglomeration centre as a central (main) square in terms of street network layout and urbanistics. Geneva: Place de Bel-Air; Basel: Marktplatz; Strasbourg: Place Kléber; Lille: Grand'Place.

(3) Construction of spatial representations of lines by means of the topological data from (e) road and railway network and with the aid of the operators' network maps. Journey time per direction was calculated by averaging the four duration values of the first two services after 7:00 (Mon-Fri) in each direction. For lines extending beyond the perimeter, journey times and line length were only considered to / from the last stop within the perimeter.

(4) Due to a lack of location-based population data in Germany, 100x100m population raster data was estimated by distributing the commune population (b) to buildings with usage type 'residential building' (f), in proportion to the area of the building.

(5) Manual digitisation of geometries not covered by (e); manual extraction of timetable indicators (number of departures, service duration) from (g). Simplifications and assumptions:

- Indicators were collected on an aggregated basis for entire lines, or for line sections if the number of departures per stop and / or service duration vary along the course of a line.
- Isolated departures that do not apply for an entire line section (e.g. to / from depot) were not considered.
- Service duration is considered only Mondays to Thursdays in order not to confuse normal services with weekend night services that are deemed to follow other principles of service provision.
- Service duration values correspond to the period of time between the first and last service per direction on a specific line or line section. Values have been rounded to 0.1 hours (6 minutes).
- If a stop is served by more than one line, the numbers of departure of all lines have been added up, and the service duration of the line with the longest service hours was adopted.
- Cross-border and domestic departures, as well as cross-border and domestic service durations have always been collected separately, even if a single line contains both domestic and cross-border departures.
- Departures limited to schooldays have been considered normally; departures limited to school holiday workdays have not been considered.
- Demand-responsive services are excluded from consideration.

(6) Derived from layer (h). Radii 750 m for railway stations, 300 m for other public transport stops (bus and tramway), since the amenability of residents to use public transport reaches a very low level beyond this distance: According to Walther (1973), at a distance of 300m of bus / tramway stops, the share of population amenable to use public transport falls below 18% (occasional public transport usage) to 25% (regular trips). For local railway stations, at a distance of 750 m, amenability falls below 22% (occasional) to 50% (way to school / education) (ibid.).

Based on Jermann (2004), the use of concentric ring buffers to calculate catchment areas of public transport has been deemed as appropriate due to its sufficient level of accuracy (±20%) for the present study and owing to the significantly higher level of data requirements and computational complexity needed to attempt better accuracy.

In case of a certain point being located within catchment areas of more than one public transport stop, the values of the stop with the highest number of departures, and the longest service duration respectively, have been adopted in the overlaying area. Values of different stops have, however, not been added in order to avoid summation of departures of different stops served by the same line.

Table 4-4: Main Spatial Analyses

Analysis		Input Datasets		Results in
A	Decrease of population density with distance from agglomeration centre and per country	(b)	Communes	5.1.3
		[a]	Agglomeration perimeter	
		[b]	Agglomeration centre and concentric rings	
B	Coverage of Agglomeration Area and Population by Public Transport Services	(d)	Population raster France and Switzerland	5.1.4
		[a]	Agglomeration perimeter	
		[b]	Agglomeration centre and concentric rings (distance 2.5 km)	
		[d]	Population raster Germany	
		[f]	Catchment areas of public transport stops	
C	Spatial Distribution of Service Quantity and Service Duration	[a]	Agglomeration perimeter	6.2.1.3
		[f]	Catchment areas of public transport stops	
D	Served Population Shares by Service Quantity and Duration	(d)	Population raster France and Switzerland	6.2.1.3
		[a]	Agglomeration perimeter	
		[d]	Population raster Germany	
		[f]	Catchment areas of public transport stops	
E	Commercial Speed by Passenger Potential per Kilometre, by Mode, and by Domestic / Cross-Border Service.	(d)	Population raster France and Switzerland	6.2.2, A.2.3
		[c]	Local public transport lines	
		[d]	Population raster Germany	
		[f]	Catchment areas of public transport stops	

4.3 Passenger Survey

In order to examine perception, satisfaction and behaviour of passengers, a questionnaire survey of public transport passengers was designed. Since it focused on the difference between cross-border and domestic passengers – and not between current and potential passengers – questionnaires were distributed directly on board of public transport vehicles.

Conducting a questionnaire survey, as opposed to telephone or oral surveys or the use of existing statistics, was a deliberate decision and aimed mainly at the following points:

- To reach people with public transport experience and with potential knowledge of the service offer (in areas with low modal shares of public transport, it would otherwise have been difficult to reach a critical mass of respondents with actual knowledge of the public transport offer and its characteristics).
- To allow for sufficient time to answer the questions (as opposed to oral interviews)
- To obtain personal, qualitative information on the individual's perception of public transport (as opposed to the quantitatively oriented statistics that already exist for certain areas)
- To obtain comparable data for different lines and agglomerations (as opposed to existing statistics that focus on one agglomeration, or parts thereof, only).

The survey was conducted on several local rail and bus lines in the cross-border agglomerations of Geneva and Basel (see Figure 4-1, Figure 4-2, Table 4-5 and Table 4-6, pp. 66-67). Most of the lines surveyed crossed the border between Switzerland and France or between Switzerland and Germany. Special attention was given to select lines with relatively high patronage (both within the single countries as well as across borders) and frequency (i.e. minimum 16 trips per direction between 7 a.m. and 7 p.m.).

In the results, all lines are referred to with anonymous names according to the wishes of some transport operators. These names follow the format Bus / Train GE (Geneva) or BS (Basel); the international letter designations CH = Switzerland, F = France and D = Germany are used in tables and figures.

The surveys were carried out on weekdays (Mon-Fri) from 11 to 21 October 2011. Care was taken to ensure that the survey was not carried out during a holiday period in any of the concerned areas. Questionnaires were distributed every day from approximately 11:45 to 19:15 (non stop), thereby covering midday and evening peaks as well as the off-peak period in between.

The questionnaire was four pages long and took approximately ten minutes to complete. It was provided in French and German, and the versions distributed on bus and rail lines varied slightly e.g. by differentiating between 'stops' and 'stations' for the indication of boarding and alighting places. Survey participants could complete the survey on board or return it later in a postage-paid envelope. Special attention was given to formulating the questions in a way that they could be understood and interpreted in the same way in the different languages.

Approximately 10,000 surveys were distributed and 3,897 valid surveys were returned for a total return rate of 38%.

The questionnaire asked a series of questions including:

- The current travel behaviour (origin, destination, trip purpose, frequency of usage on this line)
- The general travel behaviour (frequency of use of local and regional public transport within the agglomeration, use of information and ticketing channels for public transport)
- A series of satisfaction parameters on the current trip (satisfaction with service hours, frequency, price, served stops, travel time, reliability, comfort, security and the overall impression)
- The self-declared level of knowledge of the service offer on the currently used line
- The personal motivation to use public transport on the current trip
- And the socio-demographic profile (age, place of residence).

While the possibility of retroactive personal identification of participants was deliberately omitted, the use of serial numbers allows to track on which line and at what time the questionnaire was distributed.

The completed questionnaires were analysed statistically to evaluate several questions with a focus on differences in satisfaction between various groups of passengers. For the interpretation, it has been assumed that the level of satisfaction represents the subjective attractiveness of the service offer to the respondent, and that this also embodies – together with other factors such as possible alternatives – the propensity of individuals to choose this mode of transport.

In order to properly design and prepare the survey, a pre test was carried out with a prototype questionnaire on 19. August 2011 on Distribus line 3 (Basel agglomeration). The 21 returned questionnaires have been used to improve the questionnaire of the main survey and have not been included in the dataset for final analysis.

Questionnaires and a detailed overview of the sample of respondents are shown in the appendix (A.1, p. 171). The results of the survey are presented in chapter 5.2 and 5.3.

Figure 4-1: Public Transport Lines covered by the Passenger Survey (Basel)

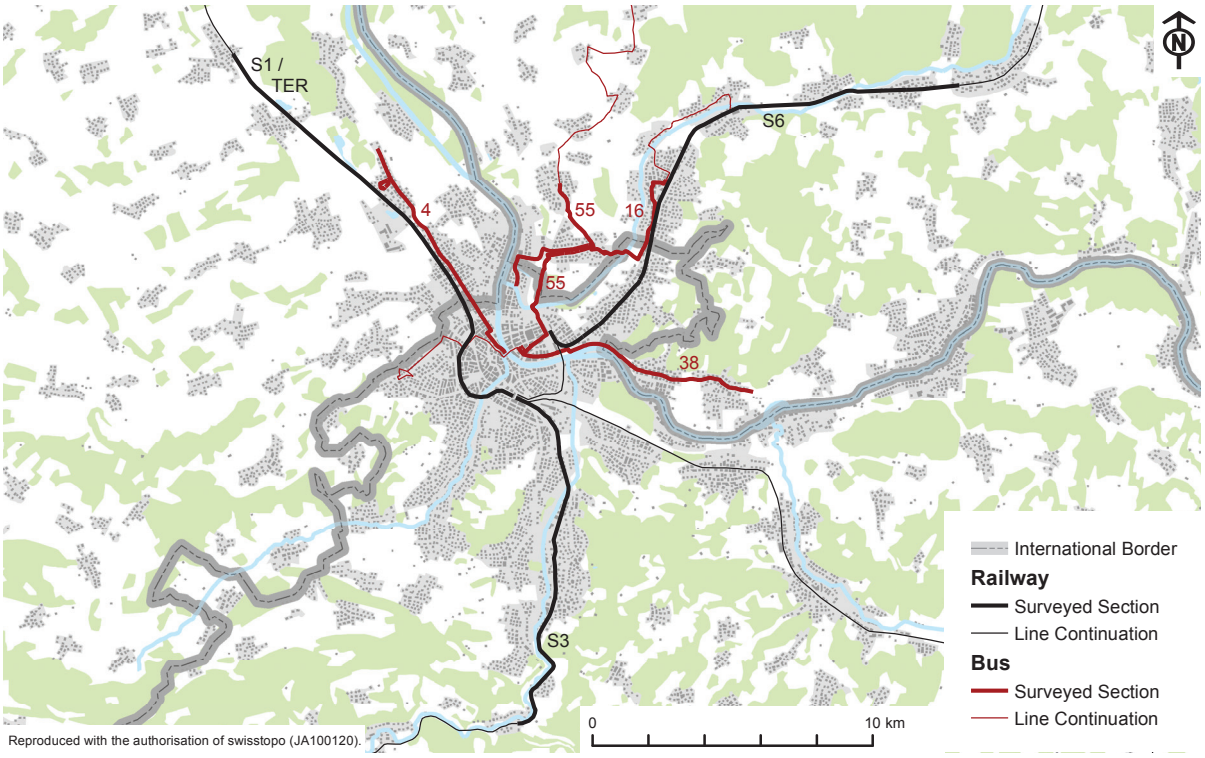


Table 4-5: Public Transport Lines covered by the Passenger Survey (Basel)

Date	Line Designation	Route	Surveyed Section	Number of Responses
Monday 17.10.2014	Bus 38	Allschwil, Dorf – Wyhlen, Siedlung	Basel, Claraplatz – Wyhlen, Siedlung	148
Monday 17.10.2014	Bus 55	Basel, Claraplatz – Haltingen (– Kandern)	Basel, Claraplatz – Haltingen	155
Tuesday 18.10.2014	S6	Basel SBB – Zell (Wiesental)	(Basel Bad Bf –) Riehen Niederholz – Schopfheim West	846
Wednesday 19.10.2014	Bus 16	Basel, Kleinhüningen – Brombach, Bahnhof	Basel, Kleinhüningen – Lörrach, Busbahnhof	83
Thursday 20.10.2014	TER / S1	Basel SBB – Mulhouse (except TER 200 trains)	Basel SBB – Bartenheim (–Sierentz (– Rixheim))	375
Thursday 20.10.2014	S3	Olten – Basel SBB – Laufen (–Porrentruy)	Basel SBB – Grellingen	297
Friday 21.10.2014	Bus 4	Basel, Schifflände – St-Louis Neuweg	Basel, Schifflände – St-Louis Neuweg	143

Figure 4-2: Public Transport Lines covered by the Passenger Survey (Geneva)

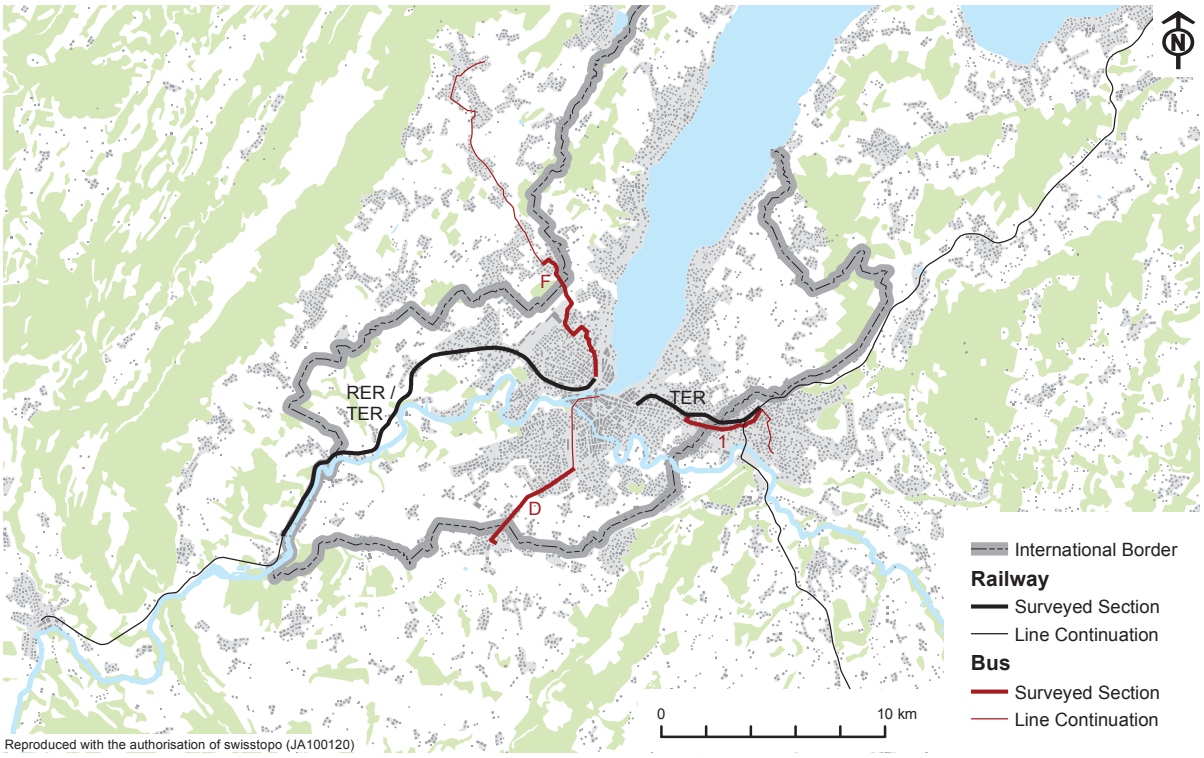


Table 4-6: Public Transport Lines covered by the Passenger Survey (Geneva)

Date	Line Designation	Route	Surveyed Section	Number of Responses
Tuesday 11.10.2011	Bus F	Genève, Gare Cornavin – Ferney-Voltaire, mairie (– Gex, ZAC)	Genève, Gare Cornavin – Ferney-Voltaire, mairie	353
Wednesday 12.10.2011	TER	Genève-Eaux-Vives – Annemasse – (Evian / St-Gervais / Annecy)	Genève-Eaux-Vives – Ambilly (–Annemasse)	429
Thursday 13.10.2011	RER / TER	Genève – La Plaine (– Bellegarde) (except non-stop trains)	Genève – La Plaine – Pougny-Chancy	670
Friday 14.10.2011	Bus D	Genève, Bel-Air – St-Julien, gare	Lancy, Bachet-de-Pesay – St-Julien, gare	290
Wednesday 19.10.2011	Bus 1	Thônex, gare Chêne-Bourg – Annemasse, Lycée Jean Monnet	Thônex, gare Chêne-Bourg – Annemasse, gare	108

4.4 Case Studies

4.4.1 Introduction

Within the scope of this project, the analyses presented in 4.2 and 4.3 have been carried out on the basis of a selection of cross-border agglomerations. This selection has been presented in chapter 2.1.2.5 and Figure 2-2 (p. 8).

The characteristics and key statistical indicators of the selected agglomerations are presented on the following pages in Table 4-7 to Table 4-10. Additionally, Figure 4-3 to Figure 4-6 show the spatial extent of these agglomerations that has been delimited according to the criteria set out in chapter 2.1.2.6, which notably excludes communes with a population density under 300 inhabitants per square kilometre. This guarantees that areas of low population density, with their very different conditions and requirements for public transport, could be excluded from consideration, notwithstanding the fact that such areas may also be part of the catchment area of an agglomeration centre and that they might therefore be included to agglomeration perimeters in other studies for different purposes.

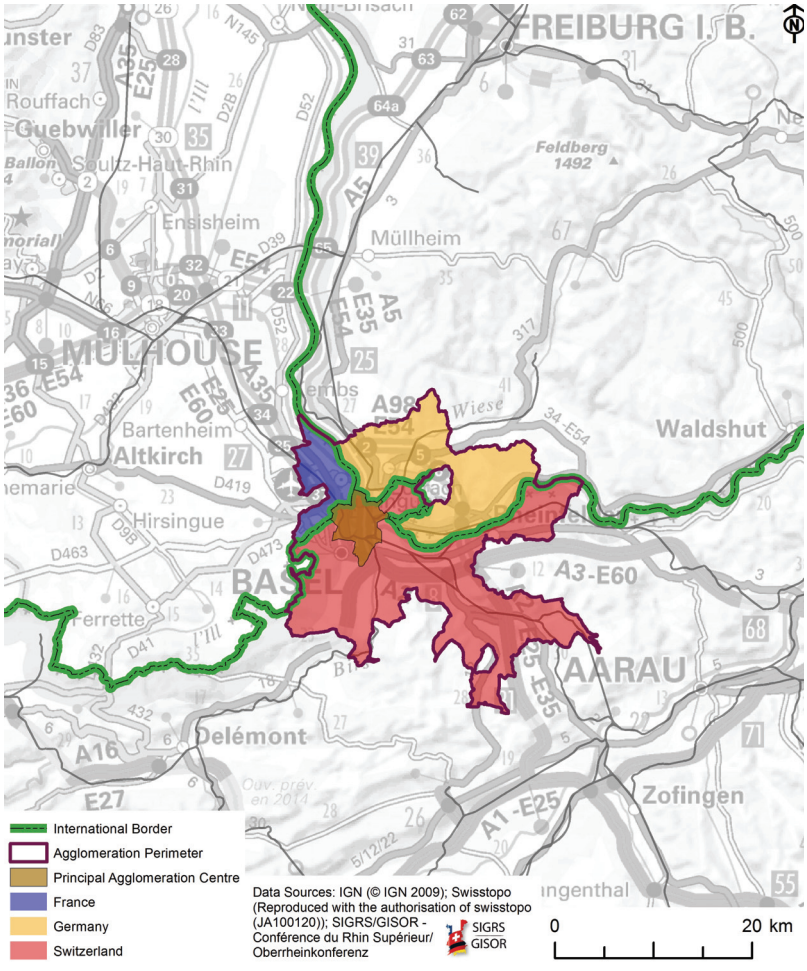
4.4.2 Basel

Table 4-7: Basel Cross-Border Agglomeration Characteristics

	Total	German Part	French Part	Swiss Part	*Thereof: Principal Centre*
Area [km^2]	507	152	40	314	*24*
Population (2006)	610'383	129'945	34'581	445'857	*163'081*
Pop. Density [km^{-2}]	1'205	851	866	1'420	*6'823*
Involved administrative districts	60 communes, 1 Landkreis, 1 Land, 1 département, 1 région, 4 cantons, 3 countries	7 communes, 1 Landkreis, 1 Land	5 communes, 1 département, 1 région	48 communes, 4 cantons	*1 commune (Basel), 1 canton (Basel-Stadt)*

Data Source: SIGRS / GISOR – Conférence du Rhin Supérieur / Oberrheinkonferenz

Figure 4-3: Basel Cross-Border Agglomeration Perimeter



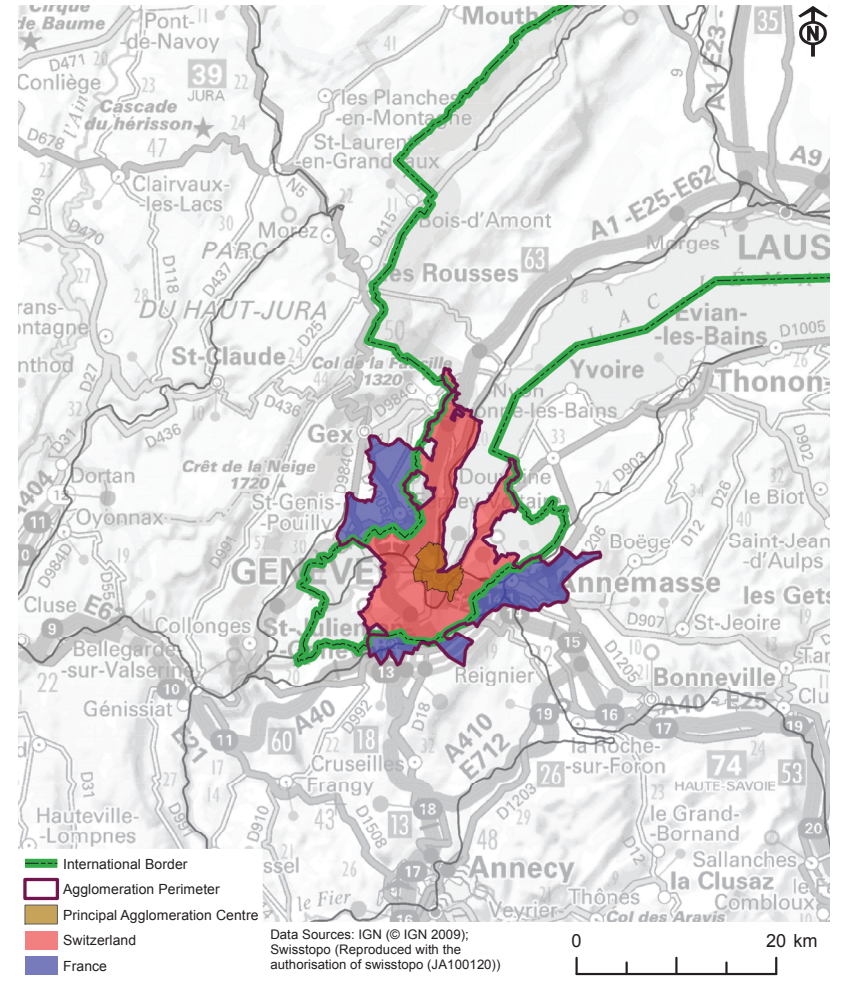
4.4.3 Geneva

Table 4-8: Geneva Cross-Border Agglomeration Characteristics

	Total	French Part	Swiss Part	*Thereof: Principal Centre*
Area [km^2]	275	107	168	*16*
Population (2006)	537'729	111'328	426'401	*178'722*
Pop. Density [km^{-2}]	1'952	1'037	2'535	*11'219*
Involved administrative districts	53 communes, 2 cantons, 2 départements, 1 région, 2 countries	17 communes, 2 départements, 1 région	36 communes, 2 cantons	*1 commune (Genève), 1 canton (Genève)*

Data Source: IGN, INSEE, Swiss Federal Statistical Office

Figure 4-4: Geneva Cross-Border Agglomeration Perimeter



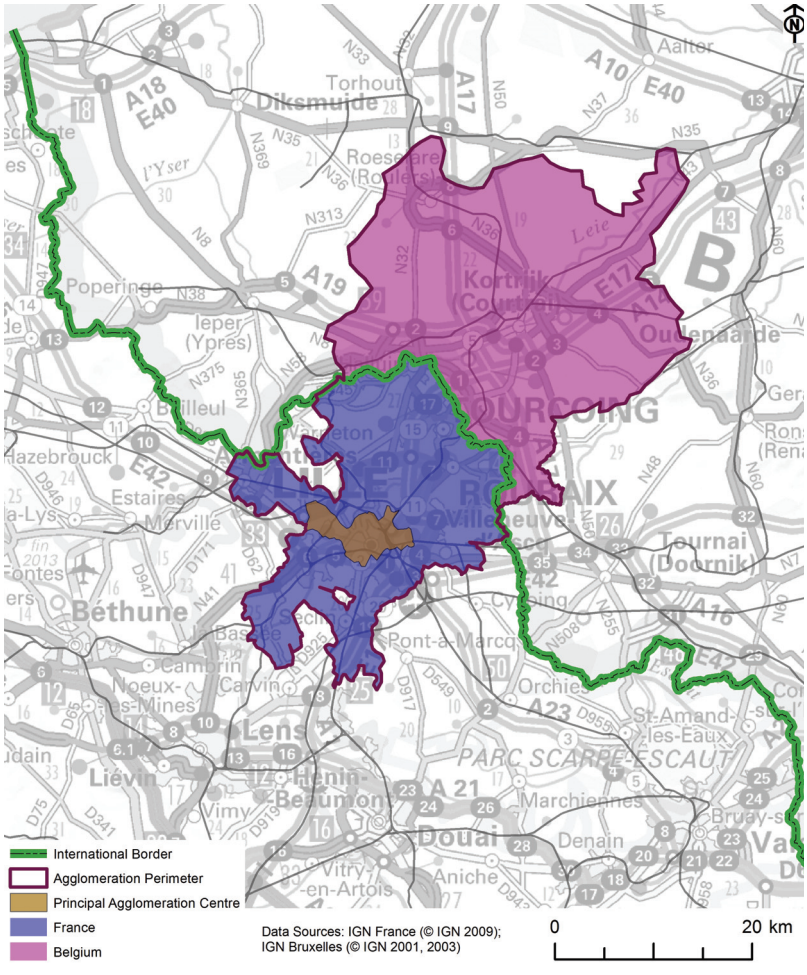
4.4.4 Lille

Table 4-9: Lille Cross-Border Agglomeration Characteristics

	Total	Belgian Part	French Part	*Thereof: Principal Centre*
Area [km^2]	1'261	769	492	*35*
Population (2011/12)	1'611'883	525'983	1'086'754	*227'533*
Pop. Density [km^{-2}]	1'279	684	2'210	*6'533*
Involved administrative districts	88 communes, 2 régions / Gewesten (B), 1 région (F) 1 département, 2 countries	23 communes, 2 régions / Gewesten	65 communes, 1 département, 1 région	*1 commune (Lille), 1 département (Nord), 1 région (Nord-Pas-de-Calais)*

Data Sources: STATBEL, IGN France, INSEE

Figure 4-5: Lille Cross-Border Agglomeration Perimeter



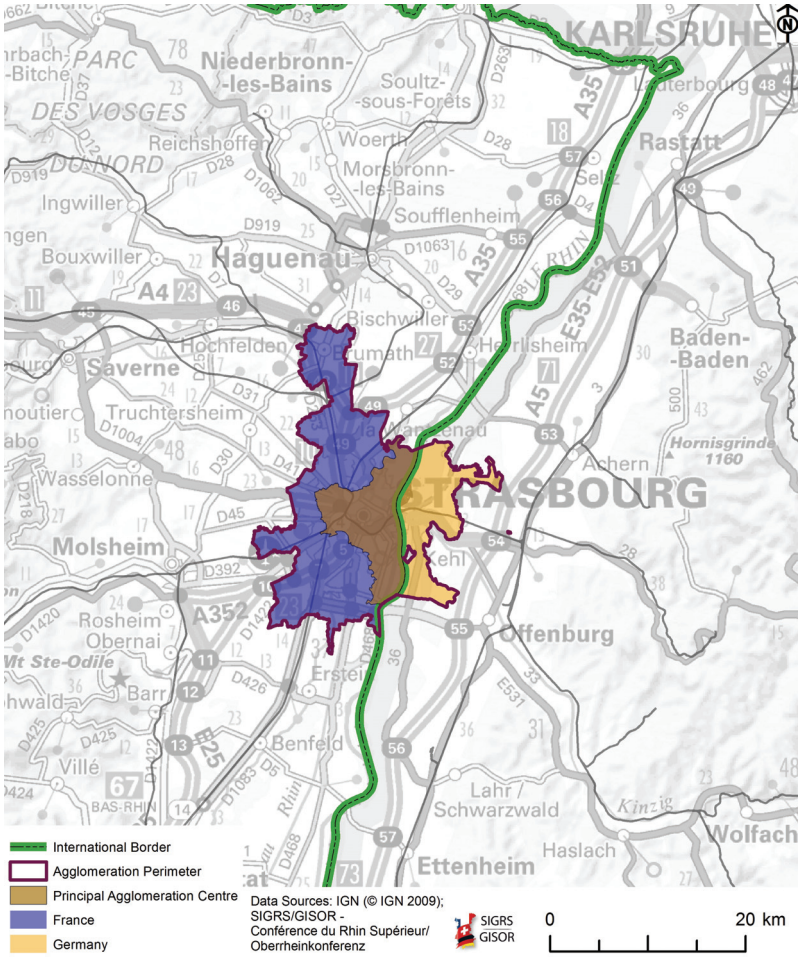
4.4.5 Strasbourg

Table 4-10: Strasbourg Cross-Border Agglomeration Characteristics

	Total	German Part	French Part	*Thereof: Principal Centre*
Area [km^2]	351	75	276	*78*
Population (2006)	497'131	34'700	462'431	*272'975*
Pop. Density [km^{-2}]	1'417	462	1'677	*3'500*
Involved administrative districts	25 communes, 1 Landkreis, 1 Land, 1 département, 1 région, 2 countries	1 commune, 1 Landkreis, 1 Land	24 communes, 1 département, 1 région	*1 commune (Strasbourg), 1 département (Bas-Rhin), 1 région (Alsace)*

Data Source: SIGRS / GISOR – Conférence du Rhin Supérieur / Oberrheinkonferenz

Figure 4-6: Strasbourg Cross-Border Agglomeration Perimeter



5 Specific Demand Characteristics

5.1 Topology and Land Use

5.1.1 Introduction

This chapter aims at identifying the spatial characteristics of cross-border agglomerations, especially in terms of spatial structures, land use and available transport infrastructures. These elements have a considerable impact on the mobility behaviour of the population and thus also on the spatial distribution of public transport demand. Moreover, they also influence how public transport services can be provided in order to cater for this demand.

The spatial agglomeration characteristics will be dealt with as follows: Cross-Border Transport Network (5.1.2), Settlement Density (5.1.3), Public Transport Coverage (5.1.4).

5.1.2 Cross-Border Transport Network

5.1.2.1 Transport Infrastructure

The current state of available infrastructures varies widely between agglomerations. Table 5-1 (for international borders) and Table 5-2 (for regional / cantonal borders) provide an overview of the number of rail and road border crossings versus the length of borders in the considered agglomerations. These numbers can be used as an indicator of the permeability of borders and the effectiveness of the cross-border transport infrastructures.

5.1.2.1.1 Road Crossings

When considering the number of road crossings, it is most striking that agglomeration parts that are separated simultaneously by a river and an international border show the lowest number of transport links: Across the river Rhine, there are only two road crossings along the 21 km border within Strasbourg Agglomeration, and only one crossing on the 10 km stretch between the French and German part of Basel agglomeration. Between the Swiss and the German part of the same agglomeration, the ratio of road crossings per kilometre is slightly higher (0.2 instead of 0.1), because this border stretch only partially coincides with the river.

Those borders that do not fall together with physical obstacles – such as a river in the examples above –, have clearly more road crossings and are therefore usually easier to be crossed. This is most evident at certain sections of the French-Belgian border of Lille Agglomeration, where the border appears so permeable that it may be difficult to even discern the border within an urban context (see Figure 5-1).

Table 5-1: Transport Infrastructures across International Borders

Agglomeration	Length of border [km] (within perimeter)	Number of road crossings (open to car traffic)	Number of road crossings per km	Number of railway crossings
Geneva (CH – F)	61	29	0.5	$1^{(c)} + 1^{(n)}$
Basel (CH – D)	47	9	0.2	3
Basel (CH – F)	25	10	0.4	1
Basel (D – F)	10	1	0.1	0
Lille (F – B)	49	28	0.6	$1 + 1^{(n)}$
Strasbourg (F – D)	21	2	0.1	1

Data sources: IGN, swisstopo $^{(c)}$ under construction; $^{(n)}$ nearby (within 5 km)

The clearly higher density of transport infrastructure across Cantonal and Regional Borders within the same agglomerations (Table 5-2) additionally stresses the low level of permeability across international borders.

Table 5-2: Transport Infrastructures across Cantonal / Regional Borders

Agglomeration	Adjacent Cantons / Regions	Length of border [km] (in perimeter)	Number of road crossings (car traffic)	Number of road crossings per km	Number of railway crossings
Geneva (CH)	Geneva Vaud	3	6	2	1
Basel (CH)	Basel-Stadt Basel-Landschaft	16	35	2.2	2
Basel (CH)	Basel-Landschaft Aargau	4	7	1.8	1
Basel (CH)	Basel-Landschaft Solothurn	12	18	1.5	1
Lille (B)	Flandre Wallonie	14	24	1.7	1

Data sources: IGN, swisstopo

Figure 5-1: Menen / Halluin Road Border Crossing (Lille Agglomeration)

Source: © Google

However, when considering the road network close to international borders in detail, some distinct phenomena can still be observed, which lead to a lower permeability of borders as compared to domestic areas:

- Road crossings of international borders typically consist of main roads or thoroughfares, whereas residential and side streets often end before borders or are closed for border crossings (see Figure 5-2 and Figure 5-3). Footpaths, in turn, are again more frequent where they do not require special infrastructure, such as bridges or subways.
- Areas next to borders have sometimes been assigned to land uses that can typically be found in peripheral areas and that act as a barrier in terms of urban development. In Basel and Strasbourg, this is the case with industrial areas and river ports; in Geneva, this applies to the airport. Both in Basel and Strasbourg, efforts are made to convert some of these areas to housing, business and leisure areas (Kanton Basel-Stadt et al. 2012; Berger 2013).

Figure 5-2: Border Permeability at Tourcoing / Mouscron Border (Lille Agglomeration)

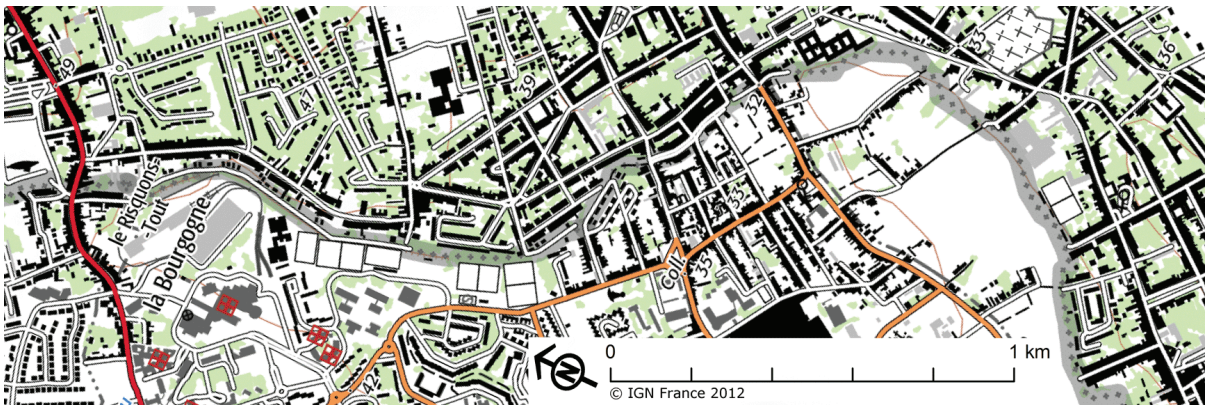
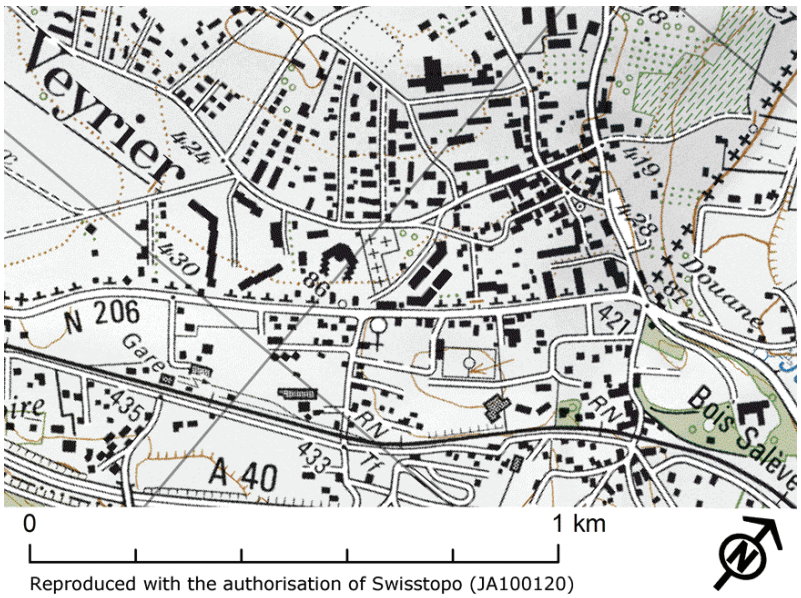


Figure 5-3: Border Permeability at Veyrier / Etrembières Border (Geneva Agglomération)



5.1.2.1.2 Railway crossings

In contrast to road crossings, railway border crossings depend to a much greater degree on historical developments. As it has already been found in chapter 2.5.1, the construction or closing down of cross-border railway lines is always subject to the relationship between the involved countries at that point in time, and it is usually a strategic decision.

For example, the relatively high number of railway lines across the Swiss-German border in Basel goes back to an interstate treaty of the year 1852 between the Swiss Confederation and the Grand Duchy of Baden, where it has been agreed that the Baden Railway station of Basel ('Basel Badischer Bahnhof') would also provide for barrier-free German domestic railway traffic, in spite of its location on Swiss territory (Freiherr von Berckheim and Bischoff 1852). From 1887 to 1890, however, in order to bypass the Swiss territory of Basel Agglomération for strategic reasons, an additional railway line from Bad Säckingen to Weil am Rhein that closely followed the German side of the border was built. Such strategic railways that have mainly been built for defence reasons can also be found in many other places (Böhler 1987). Apart from their strategic rationale, there is often little potential for traffic on such lines. Therefore, regular operations on these lines have meanwhile been suspended in many cases. This also applies to a section of the mentioned railway line near Basel, between Bad Säckingen and Schopfheim (Ebner 2011).

Other railway border crossings that existed previously include the Palmrainbrücke (Basel Agglomération) between German Weil am Rhein and French Huningue (German Hüningen at the time of construction) and the rail link between Belgian and French Comines (Lille Agglomération). In both cases, only the border crossing sections including the river bridges were closed, whereas the connecting railway network still exists.

5.1.2.1.3 Tramway lines

While many cross-border tramway lines existed both in Basel and Geneva agglomerations in the first half of the 20th century, there is currently only one occurrence to be mentioned: The Birsigtalbahn narrow-gauge railway that has been incorporated into the tram network of Basel (lines 10 and 17) serves one French village, Leymen, at the periphery of the agglomeration. At the time of its construction, the cross-border relation was not a primary goal; instead, building the route across French territory made it topographically much easier to reach the destination of the line, Rodersdorf, which is again situated on Swiss grounds.

However, new tramway lines that are centrally located and dedicated to cross-border traffic are currently under construction: A 2.5 km line extension from Basel (Switzerland) to Weil am Rhein (Germany) is scheduled to be opened in December 2014, while service on the 2.7 km tramway route prolongation from Strasbourg (France) to Kehl (Germany) is due to start in June 2016 (Kanton Basel-Stadt 2014; Stadtverwaltung Kehl 2014).

5.1.2.2 Public Transport Network

5.1.2.2.1 Network Characteristics

The network of railway lines and cross-border bus routes in the agglomerations of Geneva and Basel are displayed in Figure 5-4 and Figure 5-5. They reveal some of the typical characteristics of cross-border public transport networks:

- Most line types are of radial nature; there are very few tangential lines and no ring lines. Thus, many cross-border trips that do not start or end in the agglomeration centre lack a direct connection and can only be made with detours and / or transfers.
- Among the radial lines, there are very few lines penetrating into the agglomeration centre or even crossing the centre. Such ‘diameter lines’ require equal demand levels as well as more planning coordination on the organisational side but have both clear operational advantages (no spacious terminus stations in the city centre and less standing time for vehicles) and significant benefits for customers (more direct connections without transfers).

The only diameter bus services consist in the following routes:

(a) In Geneva, the regional T72 bus line that connects Annecy (approximately 40 km south of Geneva) to the airport in the north of the city centre up to 6 times per day serves rather regional than local purposes.
(b) In Basel, the local bus line 38 consists of a route length of 10 km on Swiss territory and 6 km on German grounds. It crosses the entire city centre, and serves contiguous communes of Allschwil (Switzerland) and Grenzach-Wyhlen (Germany). This cross-border connection has only been introduced in December 2008 but resulted (with a 30 min headway service on weekdays) in additional 210'000 passengers in the first 6 months (Südkurier 2009), revealing the attractiveness and the considerable potential of such diameter lines.

Figure 5-4: Cross-Border Local Public Transport Lines within Geneva Agglomeration

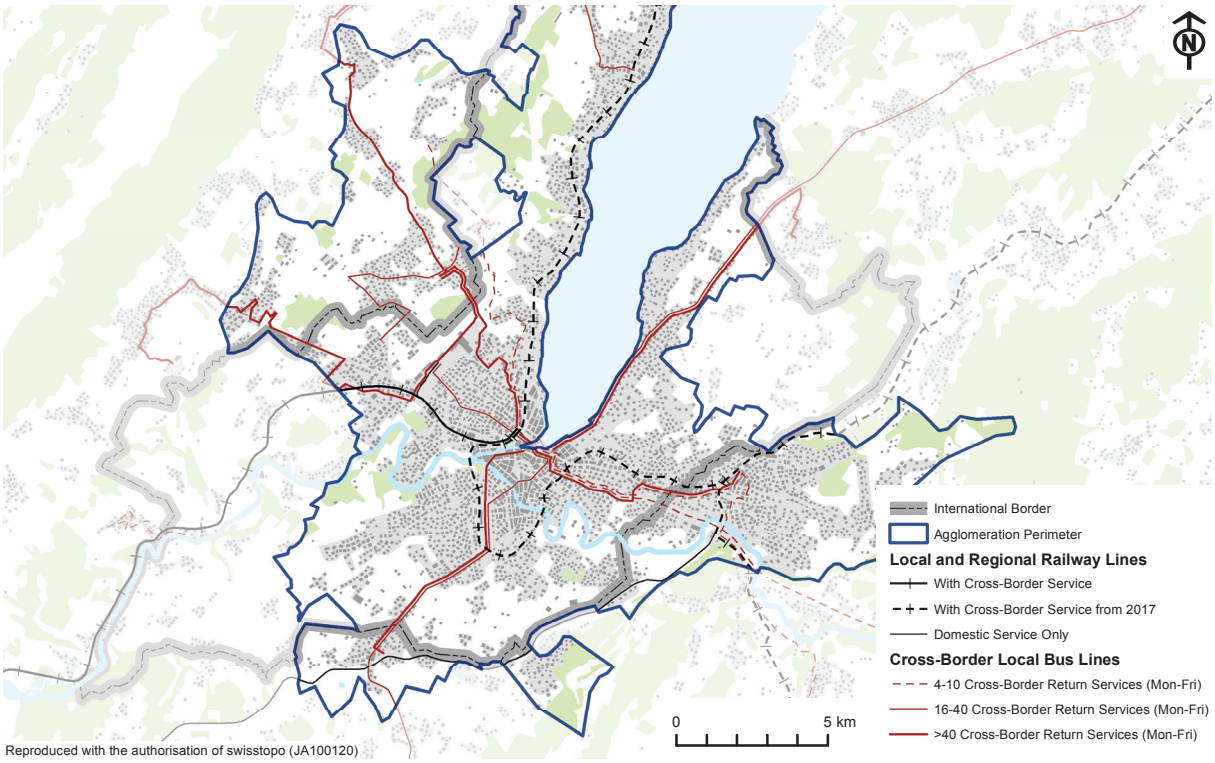
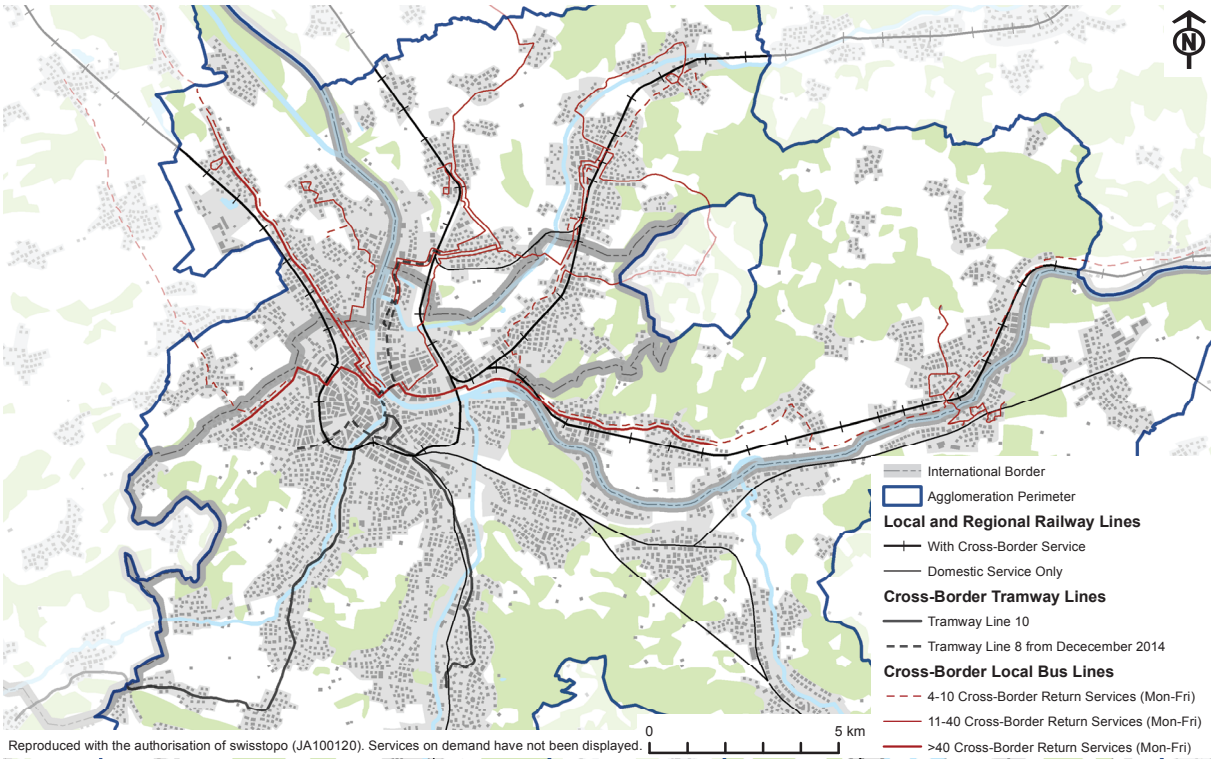


Figure 5-5: Cross-Border Local Public Transport Lines within Basel Agglomeration



As for cross-border railway lines, radial lines are the rule in all considered agglomerations. Efforts are being made to extend these lines across agglomeration centres, but with major difficulties in some cases:

(c) In Geneva, the railway networks of Switzerland and of Savoy (to the South) have never been physically connected but have ended at separate stations in Geneva since their construction in the late 19th century. The project of linking these two stations has existed throughout the 20th century, and is now finally being implemented under the title 'CEVA', named after the stations served en route (Cornavin, Eaux-Vives and Annemasse). Its completion, scheduled for 2017 but likely to be delayed, will allow the realisation of an extensive local / regional rail network 'RER franco-valdo-genevois' throughout the region with many new direct connections as well as an integrated urban development of areas around train stations (Da Trindade et al. 2011; Francey 2014). Additionally, and already in 2014, the number of traction current types in the Geneva region is being reduced from 3 to 2 in order to streamline the network and rationalise the deployment of rolling stock (Comte 2011; Keseljevic 2013)

(d) In Basel, the so-called 'green' S-Bahn line 'S1' adopted a pioneer role in 1997 by creating a new diameter route throughout the agglomeration, including the French and Swiss rail network. The specially equipped dual-current engines were licensed for operations in both countries and ensured up to 14 return services per day between Mulhouse (France) and Frick / Laufenburg (Switzerland) (Baur et al. 1997). Unfortunately, mainly owing to licensing difficulties for the succeeding generation of rolling stock in France, changing trains was again necessary at Basel SBB station from 2008, but the 'interim' concept still allowed transfers at the same platform with short connection times. However, in 2011, even this interchange connection had to be suspended due to a new timetable concept of the Alsace region that focused mainly on its domestic traffic. Since then, the re-introduction of this diameter line is frequently discussed but any short- or mid-term solution seems to be out of reach (Cassidy 2009; Rellstab 2014). A long-term project for a new railway tunnel under the city centre would allow additional stations as well as new diameter lines from Switzerland to Germany: The so called 'Herzstück' is currently in preparation, but will be opened between 2025 and 2030 at the earliest (Bau- und Verkehrsdepartement Basel-Stadt et al. 2014)

5.1.2.2.2 Line Length and Passenger Potential

Figure 5-6 explores the relationship between line length and passenger potential for all tramway and bus lines within the limits of Basel and Geneva agglomerations.

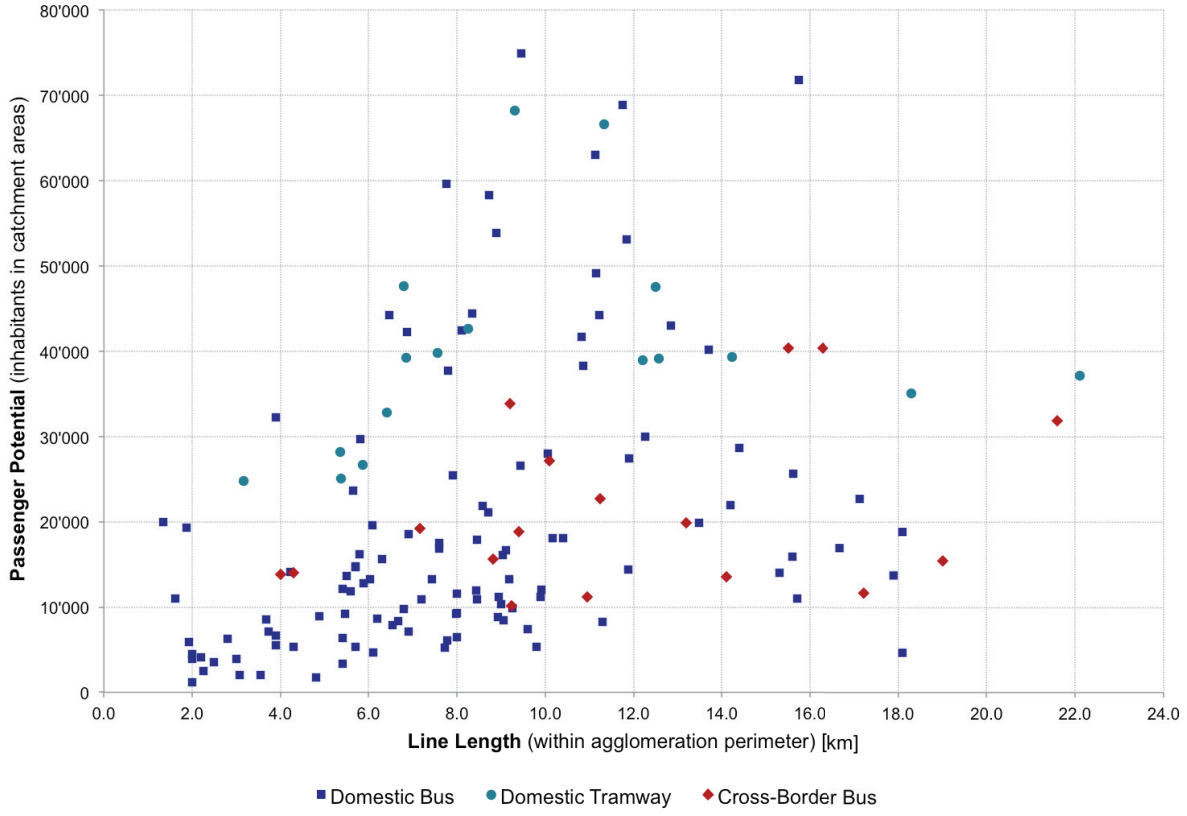
It reveals in the first place that although the shorter lines tend to have lower passenger potentials, the passenger potential per line is not only dependent on the line length, but also on factors, such as presumably settlement density and distance between public transport stops.

However, a difference between cross-border and domestic lines can still be discerned: cross-border lines do not exceed an upper limit of approximately 40'000 passengers per line, wile

domestic ones cover a much wider range up to more than 70'000. It is very likely that this relates to the frequent radial structure of cross-border lines, which prevent them from continuously running through densely populated areas throughout the course of their route.

The data shown in Figure 5-6 is displayed in detail in Table A 9 (appendix, p. 188).

Figure 5-6: Passenger Potential per Line by Line Length (Geneva and Basel)



5.1.2.3 Consequences

The data presented in this chapter shows both direct and indirect effects of international borders on transport facilities.

On the one hand, the density of transport infrastructures is lower across international borders (as compared to regional / cantonal borders within the same agglomerations), especially where borders coincide with physical elements (rivers etc.) and where the historical development did not favour the construction of cross-border transport links.

On the other hand, the lower number of international transport links (and the associated canalisation effect) lead to uneven, discontinuous transport network structures, with indirect negative effects especially for public transport: The missing transport links often incur additional interchanges and detours, which reduces the accessibility of certain (populated) areas within the agglomerations.

5.1.3 Settlement Density

5.1.3.1 Introduction

Since densely populated areas allow more efficient and rationalised public transport services, as compared to disperse and scattered settlement structures, settlement density is an important indicator for the suitability of areas for efficient public transport services. Settlement density has also been chosen as a primary indicator to define agglomeration limits, as agglomerations are regarded, amongst others, as areas with high population densities (cf. chapter 2.1.2.1).

Under the given research question of this study, it is of special interest whether international borders influence the settlement density in cross-border agglomerations. In other words: does the settlement density of areas beyond international borders differ from areas in the same country than the principal agglomeration centre?

The maps and graphs in Figure 5-7 to Figure 5-14 (pages 82 to 85) are dedicated to the depiction and the analysis of this effect in question. Obviously, population density is highest in the agglomeration centre, and it should typically decrease with increasing distance from the city centre, with the only exception of major sub-centres within the agglomeration area. In order to take account of this effect, population density has been calculated for concentric rings around the agglomeration centre with a width of 2.5 km each. Within every concentric ring, values are given for the average population density in each country. Areas outside of the agglomeration perimeter are however excluded from consideration. The point considered as the geographic agglomeration centre (e.g. a central square) is indicated in the legend of the respective figures.

The exact area and population numbers per commune are listed in the appendix (Table A 5 to Table A 8 pp. 182-184)

5.1.3.2 Course of the Agglomeration Perimeter

When considering the cartographic representations of these data, a first striking effect is given by the geographical course of agglomeration perimeters that have very uneven shapes in all considered cases. As the agglomeration perimeter represents the line where – along radial transport routes – population density falls below 300 inhabitants per square kilometre (i.e. 3 inhabitants per hectare), this shows already that in the present cases, the theoretical model of an even population decrease with increasing distance from the agglomeration centre does not apply.

In Basel, where the agglomeration extends much less into France than into Switzerland, and in Lille, where the perimeter is much more distant from the agglomeration centre on Belgian grounds than on French area, there are clear country-specific influences to the distribution of population density. In Strasbourg and Geneva, however, such an effect cannot be discerned at from the course of the perimeter only.

Figure 5-7: Population Density by Country and Distance from Agglomeration Centre: Geneva, Place de Bel-Air (map)

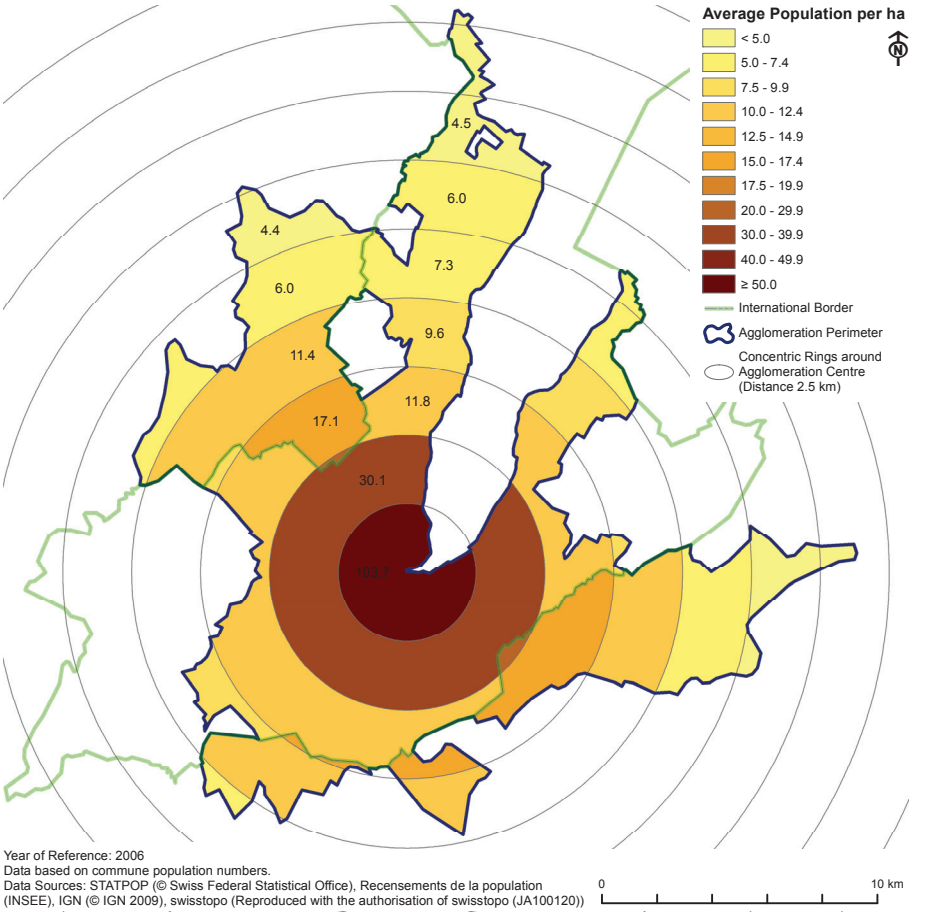


Figure 5-8: Population Density by Country and Distance from Agglomeration Centre: Geneva, Place de Bel-Air (graph)

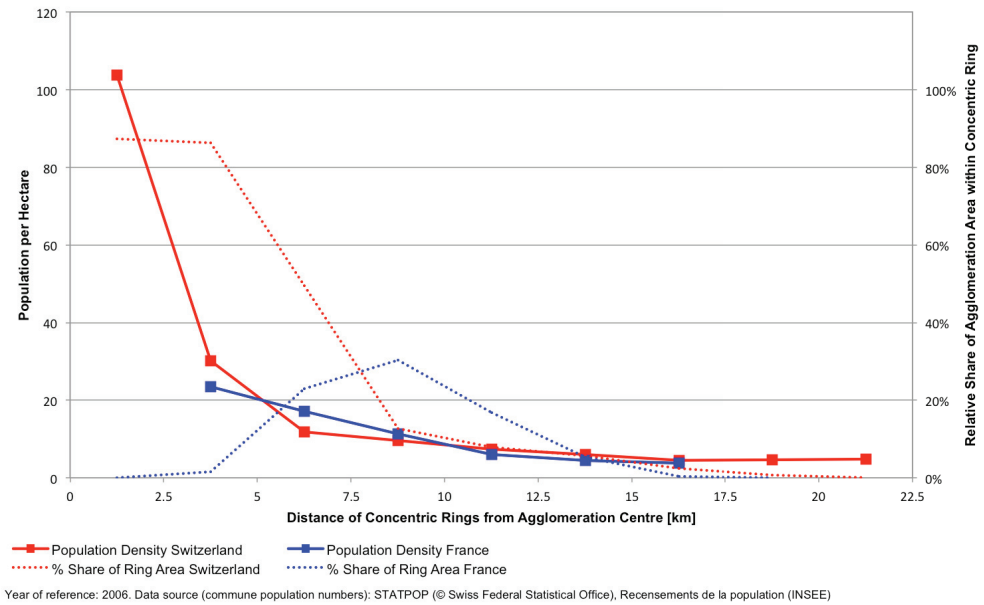


Figure 5-9: Population Density by Country and Distance from Agglomeration Centre: Basel, Marktplatz (map)

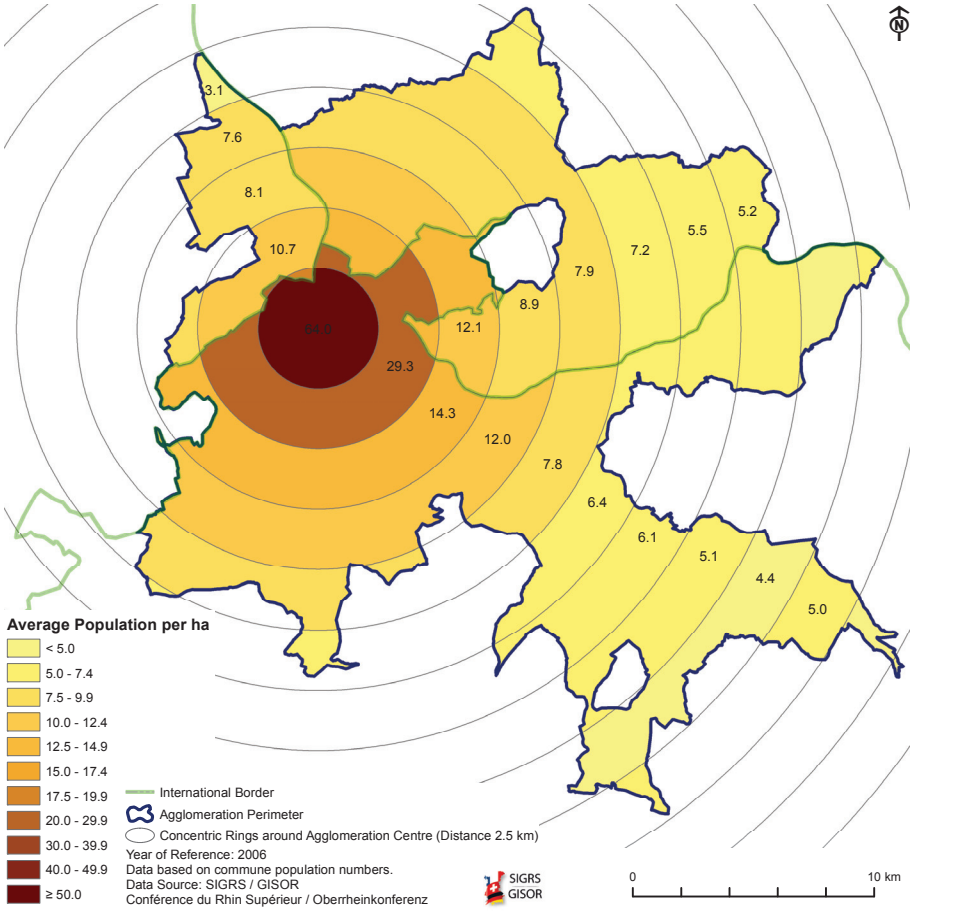


Figure 5-10: Population Density by Country and Distance from Agglomeration Centre: Basel, Marktplatz (graph)

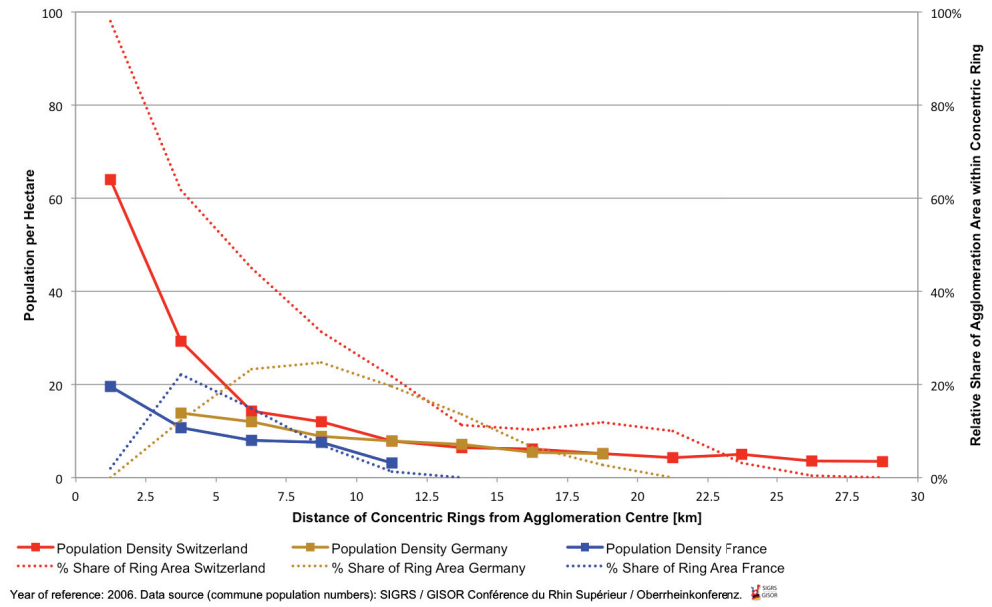


Figure 5-11: Population Density by Country and Distance from Agglomeration Centre: Lille, Grand'Place (map)

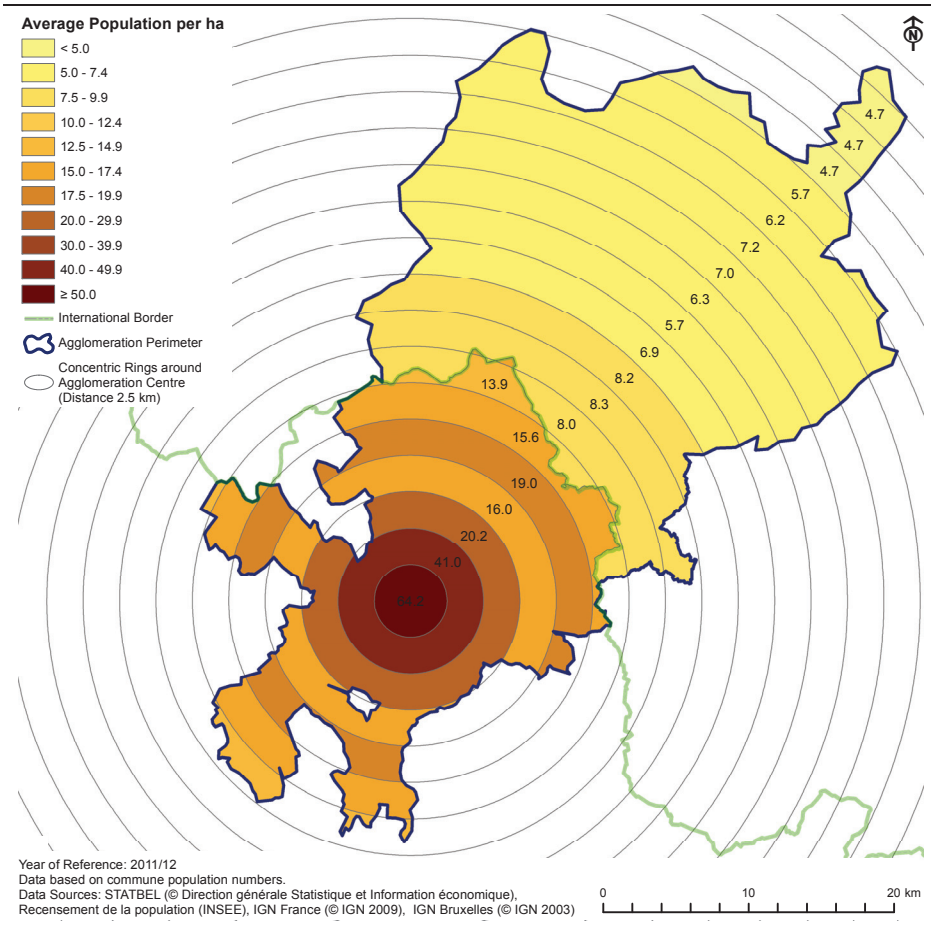


Figure 5-12: Population Density by Country and Distance from Agglomeration Centre: Lille, Grand'Place (graph)

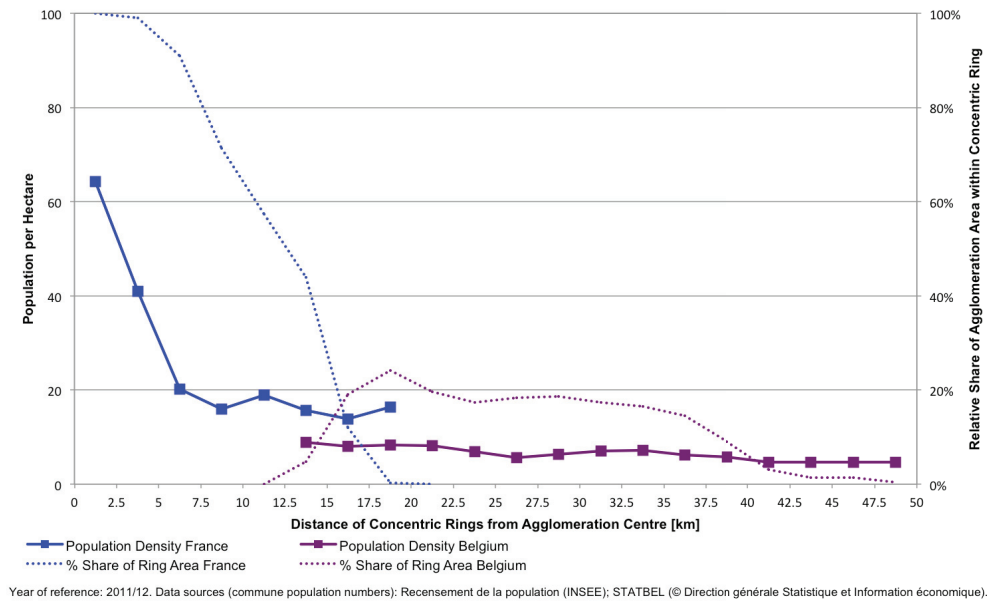


Figure 5-13: Population Density by Country and Distance from Agglomeration Centre: Strasbourg, Place Kléber (map)

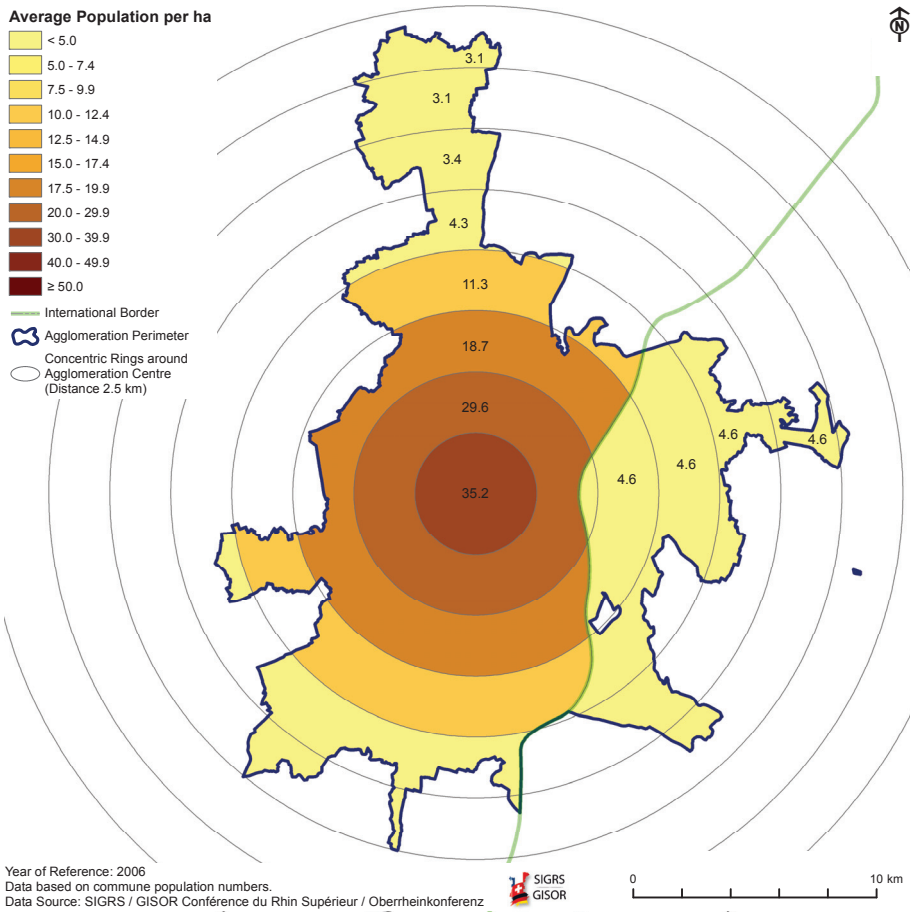
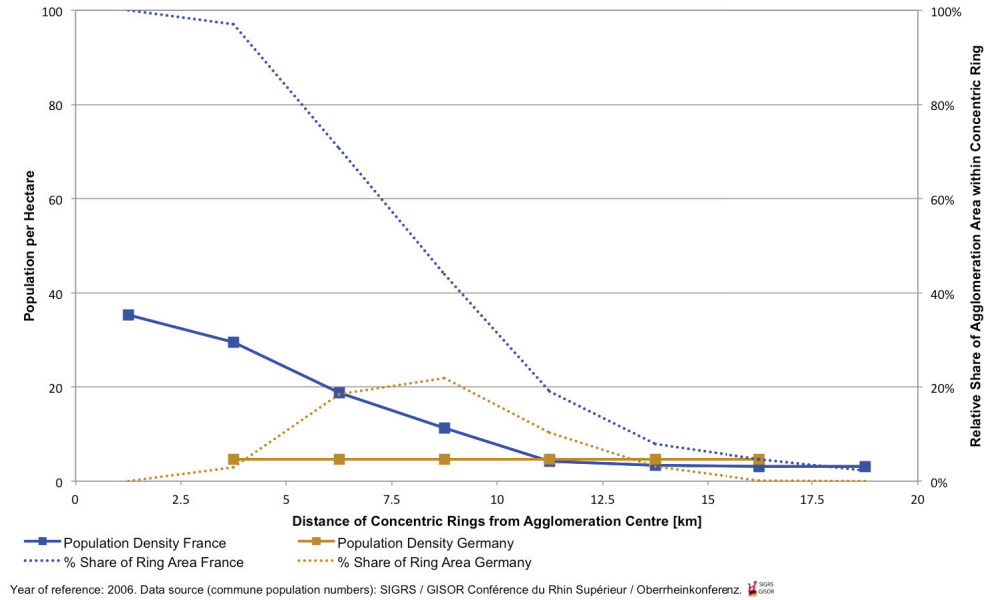


Figure 5-14: Population Density by Country and Distance from Agglomeration Centre: Strasbourg, Place Kléber (graph)



5.1.3.3 Population Decrease with Distance from the Agglomeration Centre

A closer consideration of the figures reveals the course of population decrease with distance from agglomeration centre by country. This is given both in the cartographic representations (shades and values) as well as in the accompanying graphs (solid line with square data points). Additionally, the dotted line indicates the share of area of the different agglomeration parts within the concentric rings.

In the case of Lille and Basel, the properties identified above can be confirmed: In Basel, population density decreases much slower towards France than towards Germany and Switzerland. The latter two show a similar course up to a distance of 15 km, where the share of areas considered as agglomeration areas starts dropping rapidly in Germany. In the French sector however, communes with population densities below 300 inhabitants per square meter – and thus not regarded as part of the agglomeration – start occurring already at a distance of 5 km from the agglomeration centre.

In Lille, the country-related characteristics are of different nature: In the French part of the agglomeration, population density generally decreases with distance from the city centre. The occurrence of some sub-centres results in corridor-shaped extensions of the agglomeration up to a distance of ca. 17 km. At the border to Belgium, population density drops almost by half, and decreases only slightly from there on. In the Belgian region bordering the French part of Lille agglomeration, the population seems to be much more evenly distributed, but this is only the result of the very large size of communes that originates from the extensive fusion of Belgian communes in 1975 (Belgische Federale Overheidsdiensten 2012). Therefore, the agglomeration perimeter reaches a considerable distance of up to 50 km from the agglomeration centre in Lille.

A similar effect applies in Strasbourg: While it appears that the German part of the agglomeration stretches up to 15 km from the agglomeration centre – a similar distance than the French agglomeration part –, this is only due to the above-average size of the commune of Kehl, the only German commune in the agglomeration of Strasbourg. While the town centre of Kehl, located approximately 5 km from the agglomeration centre in Strasbourg, clearly fulfils the criteria to belong to the agglomeration, this is not the case for the majority of the area of this large commune. Yet, since statistical data is unfortunately available on communal basis only, no further subdivisions can be made. The real, functional agglomeration limit, however, is clearly less distant from the agglomeration centre on the German side than in the French parts of Strasbourg agglomeration.

In Geneva, the pattern appears to be more intricate: Due to Lake Geneva, which does not belong to the agglomeration area, the agglomeration perimeter reaches right into the heart of the agglomeration centre on its north-northeastern side. With a population density of over 10'000 inhabitants per square kilometre, the agglomeration centre, consisting of the commune of Geneva, is very densely populated. Interestingly, with the exception of lakeside communes, population density decreases rapidly on Swiss areas (with communes below the threshold value of 300 inhabitants per square kilometre occurring from 6 km from the city centre),

whereas French bordering communes (in a distance of 5 to 10 km from the agglomeration centre) are more densely populated. The rapid population decrease also results in the perimeter being rarely more distant than 15 km from the city centre. The development of the local train system 'RER franco-valdo-genevois' (cf. 5.1.2.2) is expected to take pressure away from the very densely populated centre and to induce the according real estate effects around well-served public transport stations in the region (Prieur and Roselli 2010).

5.1.3.4 Consequences

The analysed data reveal that international borders do have a very clear impact on land use. It has already been suggested in Bavoux and Chapelon (2014) (Figure 2-4) that these effects can be of very different, or even opposed, nature.

The indicator 'settlement density' has been found to differ between involved countries in all four considered cases. Both differences in the distribution and in the absolute level of settlement density could be observed. However, the border does, not only act as a periphery and lead to a reduction in settlement density: In certain cases, the border was observed to have the opposite, i.e. attracting, effect. While usually, the settlement density is higher on the side of the border facing the agglomeration centre, and (sometimes significantly) lower on the other, this principle can also be reversed to the opposite (e.g. in the agglomeration of Geneva).

In either situation, borders represent a discontinuity in population density that renders the distribution of the agglomerations' population more uneven.

Additionally, in this unevenly structured environment, agglomeration-wide public transport services cannot be provided as efficiently as it is possible in agglomerations with a more even population distribution.

5.1.4 Public Transport Coverage

5.1.4.1 Introduction

After considering the characteristics of public transport networks and of the distribution of the agglomerations' inhabitants, it is also of interest to which extent the domestic and cross-border public transport networks actually cover the agglomerations' residents.

The catchment areas of public transport stops (300 m radius for tramways and buses, 750 m for railways, cf. Table 4-3), as well as a high-resolution raster of the population distribution of Geneva and Basel agglomerations are displayed cartographically in Figure 5-15 and Figure 5-16.

For quantitative analyses and comparisons, the agglomeration areas have been divided by international borders as well as by concentric rings (5, 10 and 20 km from the agglomeration centre). The extent to which the population of these agglomeration sectors resides within reach of public transport is depicted by graphs in Figure 5-17 and Figure 5-18.

It is important to note that at this stage, no distinction has been made between different service levels. Instead, all public transport stops with at least three departures per workday have been taken into consideration. Service frequency and quality will be analysed separately in chapter 6.1.

5.1.4.2 Coverage of Population by Public Transport Network

Considering the population share residing outside the catchment area of public transport stops, this amounts overall to approximately 10% in both Geneva and Basel agglomerations. Some differences, however, become apparent when differentiating between countries and according to distance from the agglomeration centre: In Geneva agglomeration, residents farther than 10 km from the agglomeration centre are to a higher extent out of reach of public transport: 24% of these residents in the Swiss part, and as much as 67% in the French part.

In Basel agglomeration, these differences are less distinct: The lowest public transport service coverage can be found in a distance of 5-10 km from the agglomeration centre, both in the Swiss and French Part, where slightly more than 20% of inhabitants reside outside of catchment areas of public transport stops.

Again, only areas within the agglomeration perimeter (i.e. communes with a minimal population density of 300 inhabitants per square kilometre) have been taken into account in order to maintain a certain degree of comparability. The encountered differences would presumably be even stronger if the concentric rings also included areas outside the perimeter.

Figure 5-15: Public Transport Coverage within Geneva Agglomeration (map)

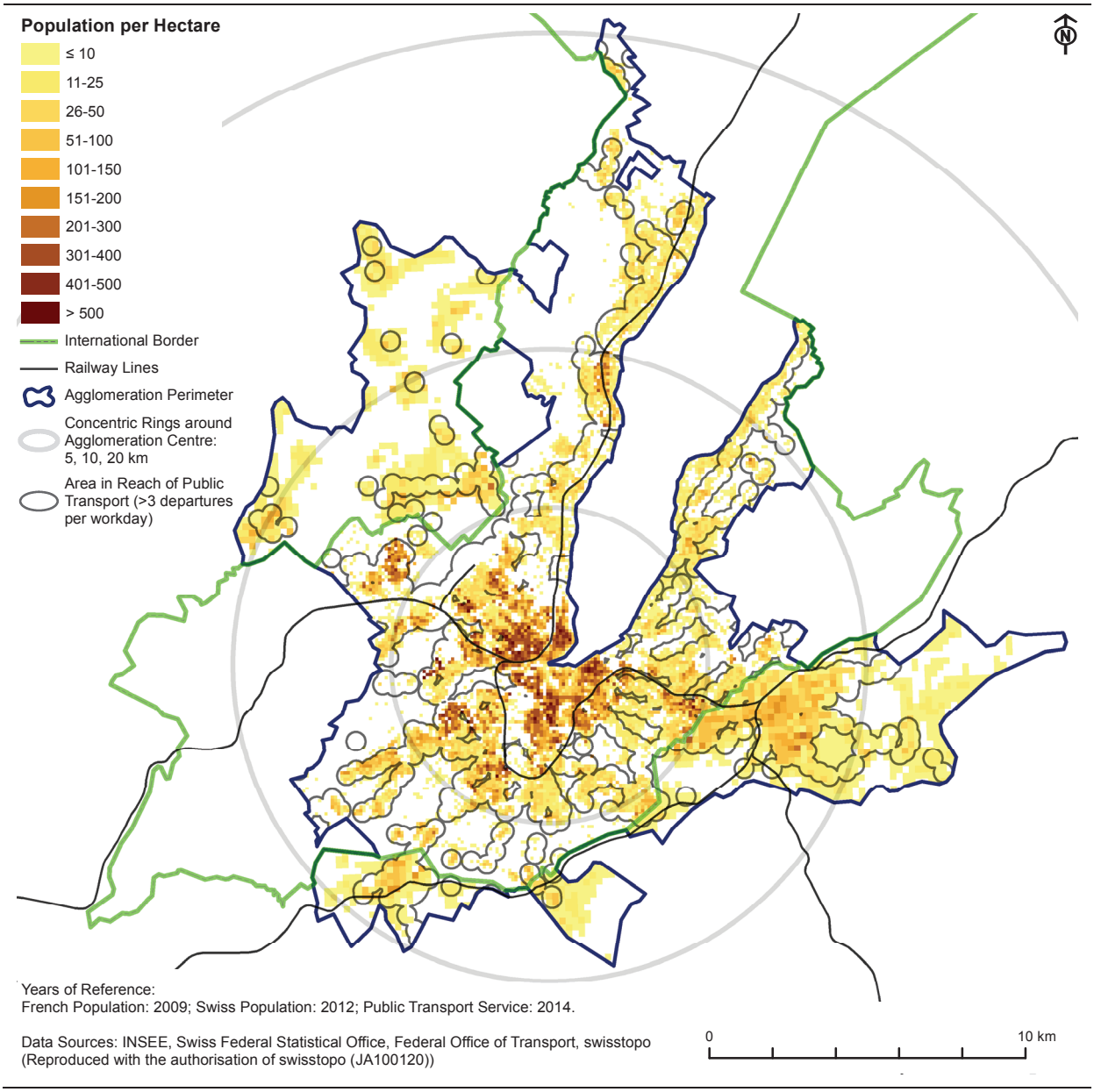


Figure 5-16: Public Transport Coverage within Basel Agglomeration (map)

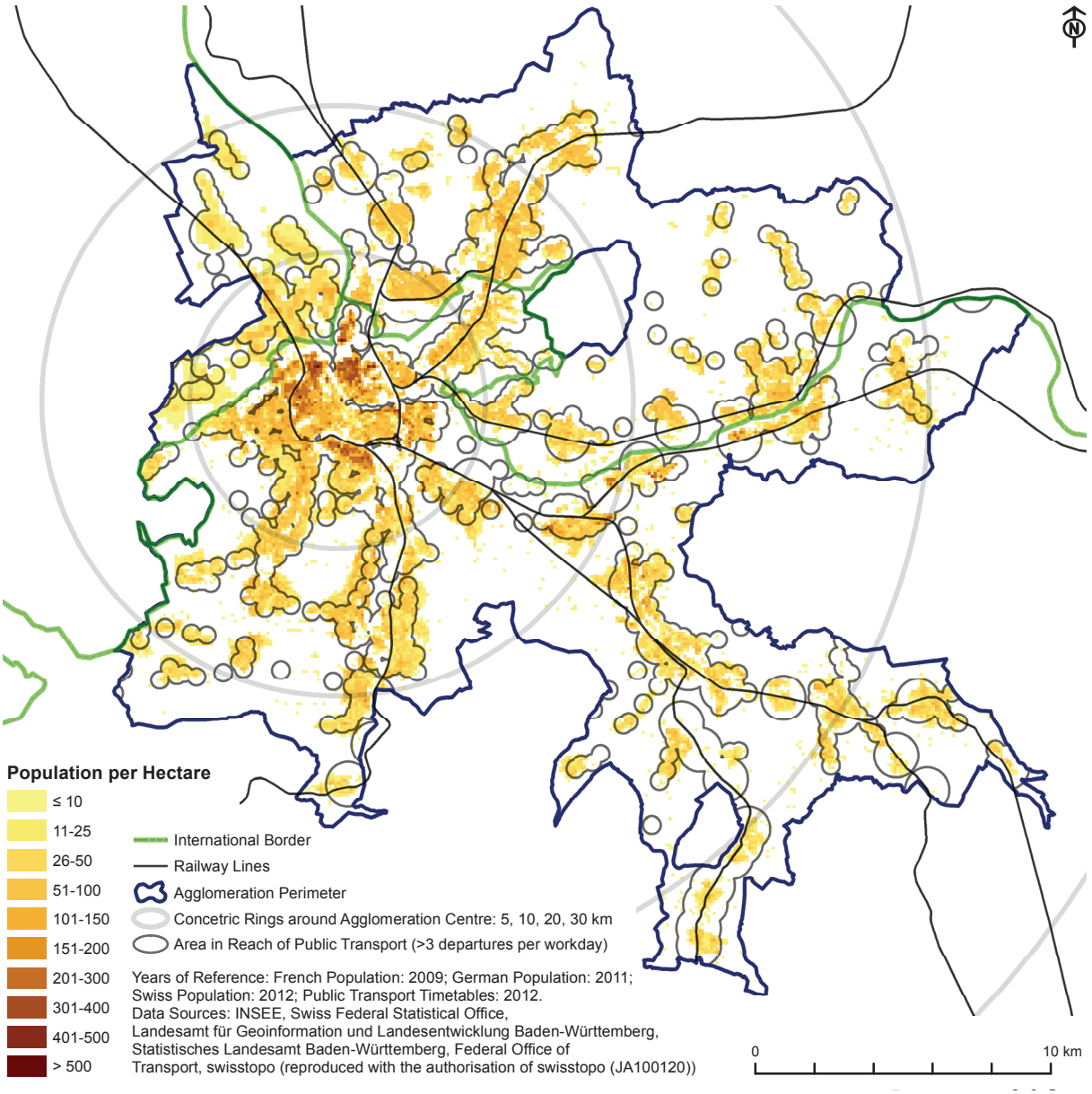


Figure 5-17: Public Transport Coverage of Population within Geneva Agglomeration

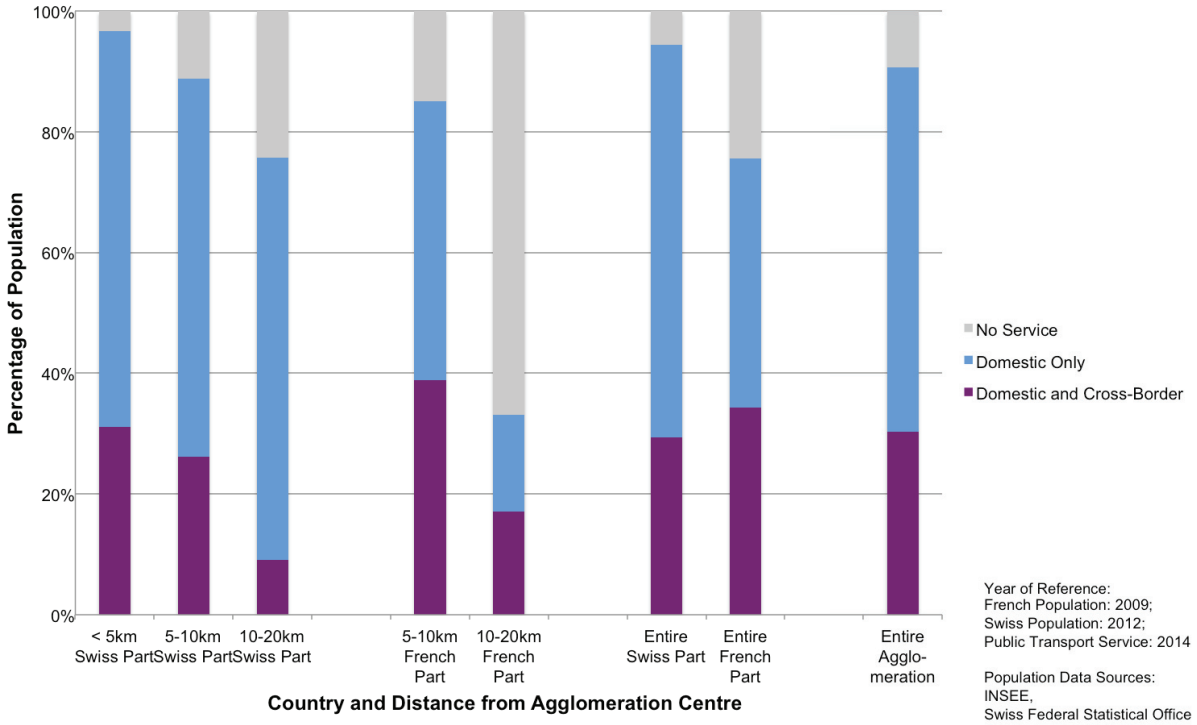
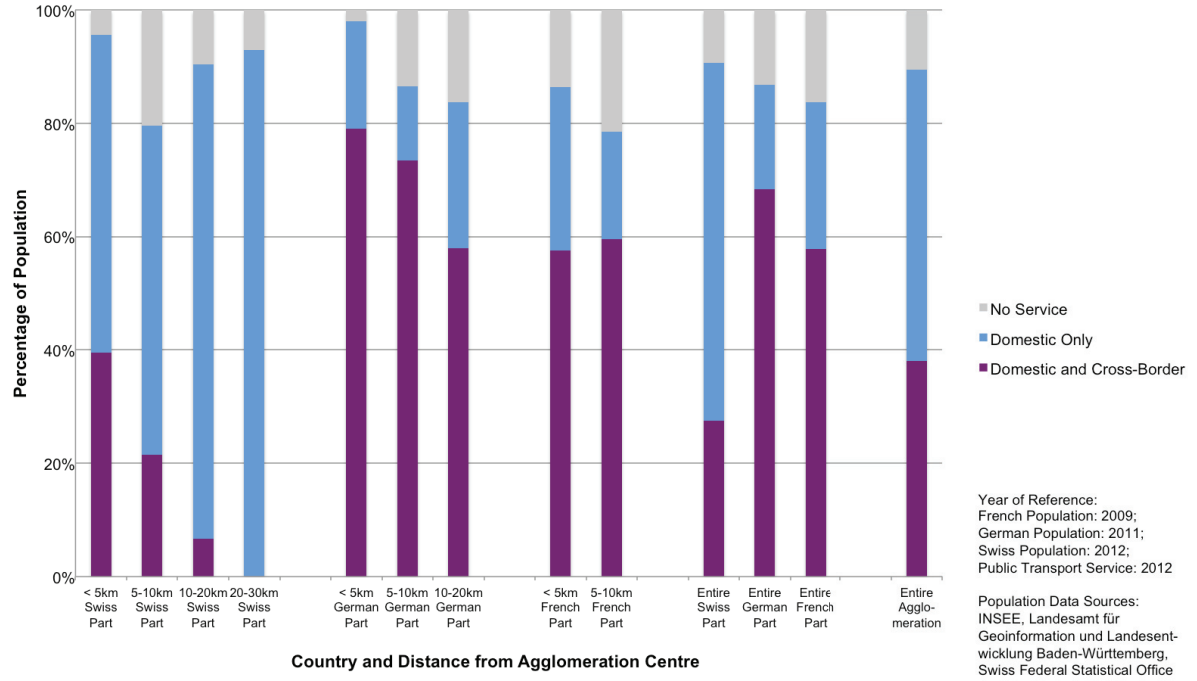


Figure 5-18: Public Transport Coverage of Population within Basel Agglomeration



5.1.4.3 Coverage of Population by Cross-Border Public Transport Network

Interestingly, while around 90% of the two agglomerations' populations are in reach of public transport, a much smaller share is also directly served by cross-border public transport: 30% in Geneva agglomeration and 38% in Basel agglomeration. These shares are also subject to significant variations throughout different parts of agglomerations: In the country of the agglomeration centres – Switzerland in both cases –, the catchment areas of cross-border services cover less residents than in the French and German agglomeration parts. On the other hand, in the French and German agglomeration parts, the cross-border public transport services are more widespread.

Additionally, the coverage of cross-border services tends to be lower, the higher the distance from the agglomeration centre. This is however partially explicable by the tendency that places far from the agglomeration centre are often also distant from the border and therefore less served by cross-border services.

These effects apply to both Geneva and Basel, but they are especially distinctive in the case of Basel. It is very noticeable that certain agglomeration areas are barely – or not at all – served by cross-border services. Also, the significant variations in the share of people outside public transport catchment areas are conspicuous and underline the differences in density of public transport networks and their areal coverage in different countries of the considered agglomerations.

5.1.4.4 Consequences

The significantly lower spatial extent of the cross-border public transport network – as compared to the overall public transport network – results in a lower accessibility of areas beyond a border. Surely, all origin-destination relations can still be connected by changing tramways, buses or trains one or several times. The attractiveness of such trips is however clearly impaired by the inconvenience of changing vehicles, the additional travel (interchange) time, as well as by lower reliability due to the possibility of missing connections. Under such circumstances, it is much more difficult to attract customers to public transport and to increase its modal share.

5.2 Demand Structure

5.2.1 Introduction

The following chapter aims at analysing quantities and qualities of transport demand across borders. It addresses overall volumes of cross-border traffic, modal shares and trip purposes of cross-border trips as well as the temporal distribution of transport demand across borders. These characteristics of transport demand are of high importance for the adequate provision of transport systems.

In the context of this study, it is of special interest whether the qualities and quantities of transport demand differ between cross-border and comparable domestic relations. And if this is the case, how can the differences be explained?

The analyses are carried out on the basis of the selected case studies. As statistics from different sources are used, agglomeration delimitations may vary, and numbers may date from different years. While this exemplarily shows the difficulty in finding comparable statistics in a cross-border context, the numbers here are mainly shown for a general impression of the range of values, rather than for comparing small differences. Also, as it can be seen in the following sections, border effects are clear enough that these imprecisions can be tolerated.

5.2.2 Quantities and Modal Split

Table 5-3 provides an overview of the overall volume of cross-border traffic and the main trip purpose of cross-border journeys in the agglomerations of Basel and Geneva.

Even though the numbers of Geneva and Basel are not entirely comparable due to different measurement standards (cf. note * in Table 5-3), the high numbers of trips per direction and day are very striking. They show that it is not at all a negligible amount of traffic crossing borders every day. Thus, the entire problem of providing adequate transport systems is of central importance.

Table 5-3: Number of Cross-Border Trips per Working Day

Border	Geneva – France	Basel – France*	Basel – Germany*
Trips per Direction	187'975	34'300	58'600
Main Trip Purpose	Travel to Work (>50%)	Travel to Work (63%)	Travel to Work (41%)
PT modal share	7%	10%	14%
* Only trips with destination in the Swiss part of the agglomeration (no transit), 6-20h			
Data sources: Geneva: Citec Ingéneur Conseils SA (2012); Basel: PTV France (2012)			

In contrast to the high demand numbers, which might evoke the assumption that the passenger potential is high enough for the efficient deployment of public transport means, the actual modal shares of public transport across international borders is relatively low with levels between 7% and 14%. In certain cross-border (commuting) corridors of Geneva, modal shares of public transport are as low as 2% (Citec Ingénieurs Conseils SA 2012).

The low level of modal share of public transport across international borders becomes evident when comparing these values to domestic ones. Both cantons Basel-Stadt and Geneva are primarily urban cantons, and while the agglomerations extend well beyond the external borders of the cantons, the principal agglomeration centres are located centrally within these cantons. Therefore, those stretches of the cantonal border that do not coincide with the international border can serve as a domestic comparative counterpart to those stretches that do fall together with the international border.

A comparison of public transport modal shares across these those two border types is given in Table 5-4. The differences are evident: Within the same agglomerations, at approximately the same distance from the city centre, modal split values are clearly different: public transport modal shares are much lower across international borders, than across cantonal (domestic) borders.

This difference can barely arise by chance. Rather, is likely that they are to be considered in relation to other identified differences, such as the spatial framework conditions (chapter 5.1), the service offer (chapter 6.2) and further aspects of the following chapters.

The consequences, however, are clear: In an urban context with limited areal availability, public transport systems are much more efficient than individual transport in terms of required space, both for the transport itself and for parking space requirements (Weidmann et al. 2011).

Table 5-4: Modal Share of Public Transport at Cantonal and International Borders

Canton	Geneva	Basel-Stadt**
PT modal share across international borders	7%	23%
PT modal share across cantonal borders	33%	38%
** Only trips between the city of Basel and the remaining agglomeration		

Data sources: Geneva: Citec Ingéneur Conseils SA (2012); Basel: Hochbau- und Planungsamt Basel-Stadt and Amt für Raumplanung Basel-Landschaft (2007)

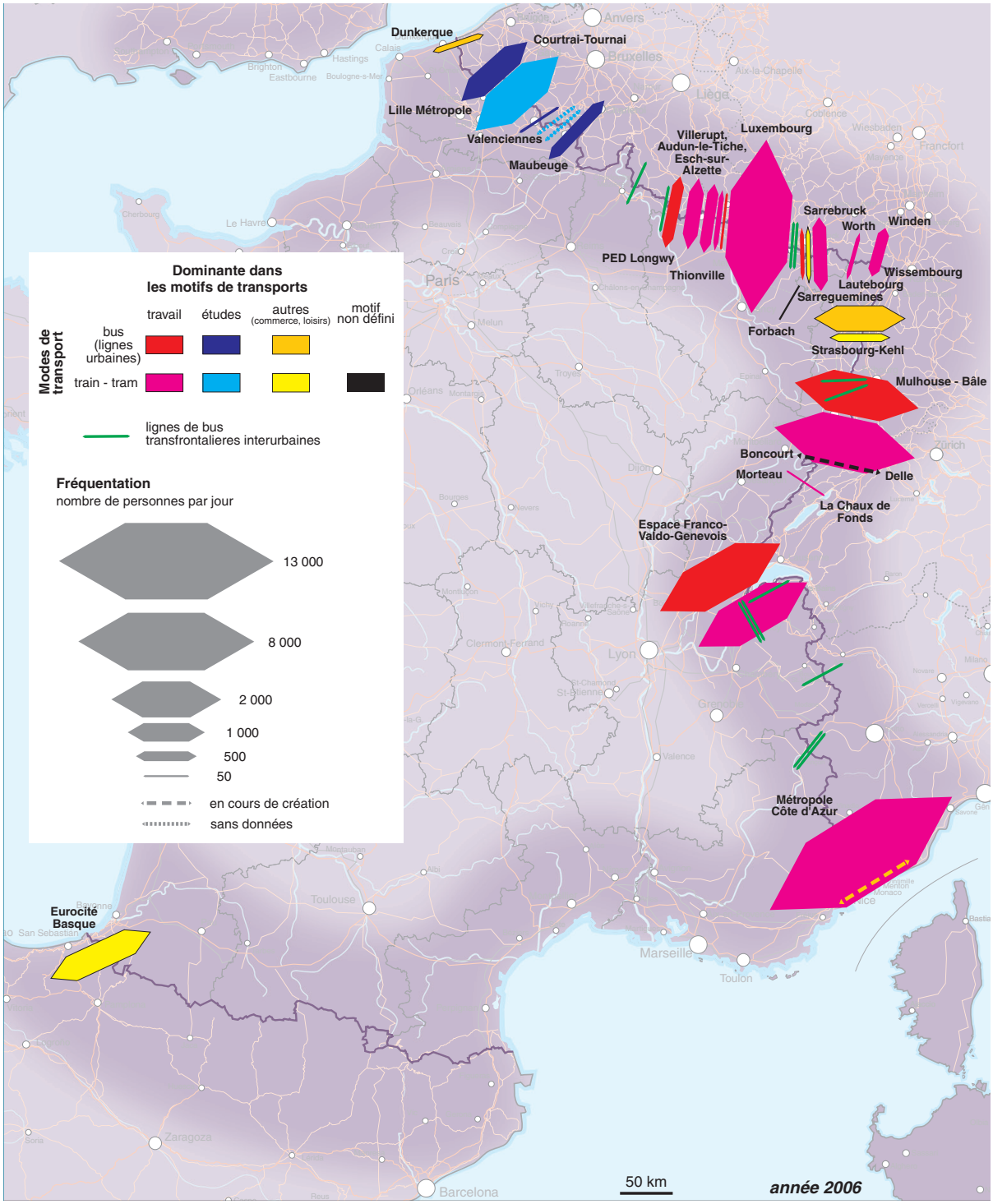
Note that for the case of Basel, the numbers in Table 5-4 originate from other sources than those in Table 5-3. Comparisons between these two tables are not possible.

5.2.3 Trip Purposes

As shown in Table 5-3, cross-border trips on local public transport are clearly dominated by the trip purpose ‘travel to work’ for both Geneva and Basel. While this trip purpose is also predominant for cross-border motorised private transport (Basel 47%, Geneva >52%), its share is even higher for cross-border local public transport (Basel 55%, Geneva >54%) (Citec Ingénieurs Conseils SA 2012; PTV France 2012). Also, study / education trips can barely be found on cross-border motorised private transport, while on cross-border local public transport these trips amount to >7% in Geneva and 13% in Basel (ibid.). On the contrary, shopping trips across borders are less frequent on local public transport (Basel 9%, Geneva 2%) than by motorised private transport means (Basel 19%, Geneva >7%) (ibid.).

However, while trips for work purposes usually predominate on cross-border local public transport services, as it is the case in Geneva and Basel, this does not apply in all agglomerations. Figure 5-19 shows that in Lille, ‘studies / education’ in Lille is the most important trip purposes on local public transport across borders. In Strasbourg (ibid.), Aachen and Maastricht (Juchelka 1996), however, shopping and leisure are the most frequent trip purposes. Thus, the mix of trip purposes should understood as a result of the actual function of the border, the differences between the border regions, and the specific travel incentives this evokes.

Figure 5-19: Passenger Volumes and Predominant Trip Purposes on Local Public Transport Services across the French External Border

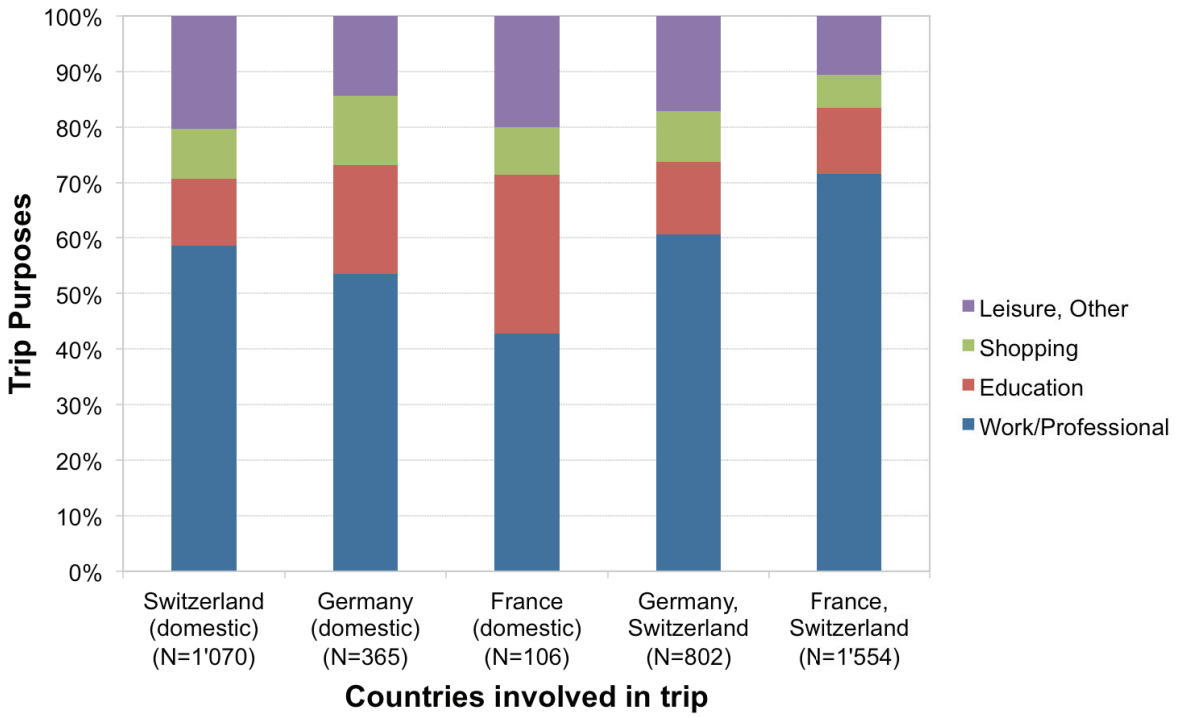


Source: © Mission Opérationelle Transfrontalière and AEBK (2007)

These above-mentioned shares of trip purposes of Geneva and Basel, which originate from statistics with very high samples correspond fairly well with the shares of trip purposes of the dedicated passenger survey that has been carried out for this study on local public transport lines in Geneva and Basel (see Figure 5-20), even though the questionnaire distribution time from 11:45 to 19:15 may have somewhat impaired the comparability to other statistics.

Figure 5-20 also reveals that for domestic trips, trip purposes tend to be slightly more mixed, and work / professional trips are not as dominant as they are in cross-border traffic, especially between France and Switzerland.

Figure 5-20: Trip Purposes on Local Public Transport in Geneva and Basel



Source: Own Survey (2011), cf. chapter 4.3

However, when analysing cross-border trips additionally according to the country of residence of passengers (Figure 5-21), the trip purpose ‘work / professional’ reveals to be even more dominant among German and French residents: More than 70% of French and German residents who use local public transport for their trips to Switzerland, do so for work / professional purposes.

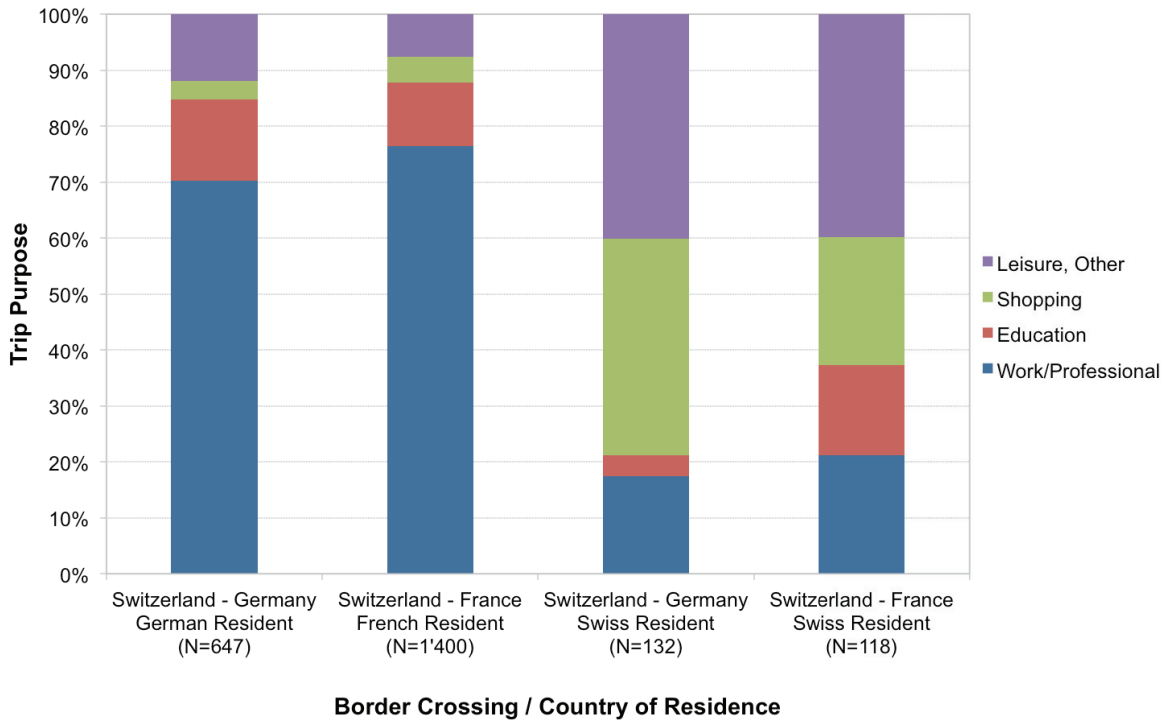
On the other hand, only about 20% of Swiss residents travel on cross-border local public transport for work / professional purposes. For trips to Germany, approximately 40% use public transport for shopping purposes, while other 40% travel for leisure or other reasons. Almost no passengers have ‘education’ as their trip purpose.

The split of travel purposes among Swiss residents on cross-border trips to France is similar to Germany, with the only exception of slightly more trips for education purposes and a similarly lower share of shopping trips.

This makes it very clear that work commuter flows are of very unidirectional nature in the agglomerations of Geneva and Basel: they are directed from German and French suburbs as places of residence towards Switzerland where many jobs are located.

As can be seen from the number of respondents of the different passenger groups in Figure 5-21, French and German residents constitute quantitatively the vast majority of users of the surveyed local cross-border lines. The high shares of shopping and leisure trip purposes among Swiss residents can by no means compensate the low shares of these trip purposes among German and French residents: The cross-border lines remain dominated by passengers travelling for work / professional purposes.

Figure 5-21: Trip Purposes by Country of Residence on Local Cross-Border Lines in Geneva and Basel



Source: Own Survey (2011), cf. chapter 4.3

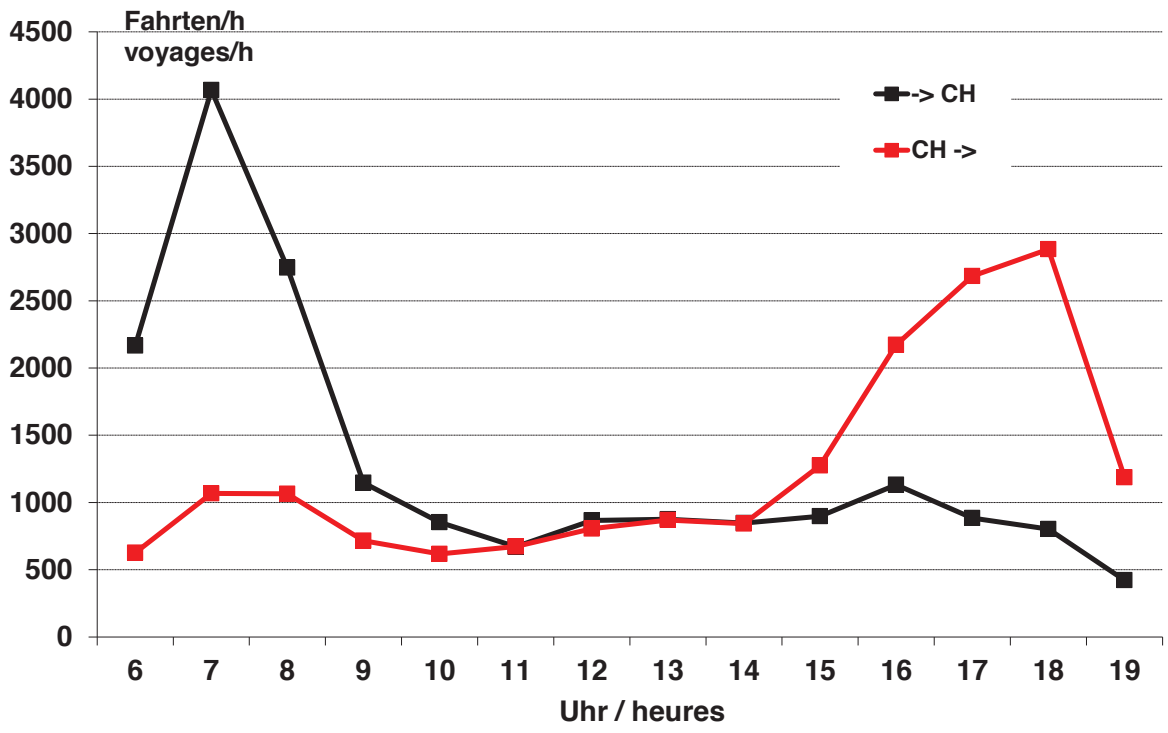
Shopping and leisure trip purposes are further analysed in chapter 5.3.3.

5.2.4 Temporal Distribution

The specific temporal distribution of traffic is one of the direct repercussions of the strong dominance of trips for work purposes on cross-border relations within the agglomerations of Geneva and Basel. In the case of an economic gradient across a border, traffic flows are additionally concentrated by direction:

On cross-border local public transport lines in Basel agglomeration, 22% of daily traffic (i.e. traffic from 6h to 20h) from France and Germany to Switzerland arises within one hour, the peak hour from 7h to 8h (PTV France 2012). The traffic volume during the three hours from 6h to 9h amounts to exactly the half of daily traffic (ibid.). As shown in in Figure 5-22, demand during the remaining times of the day remains at a low level, with the only exception of the (less intense) evening peak in the opposite direction.

Figure 5-22: Number of Cross-Border Trips per Hour and Direction on Local Public Transport within Basel Agglomeration (Sum of all Lines)



Source: © PTV France (2012)

In Geneva, a similar situation can be found: 48% of passengers travelling from France to Geneva on local public transport between 6:30 and 20:30 (or 45% of passengers within 24 hours) do so in the morning peak between 6:30 and 9:30 (Citec Ingénieurs Conseils SA 2012).

This morning peak is stronger for cross-border traffic than in the domestic context: Only 41% of passengers entering Geneva by public transport from the neighbouring Swiss canton of

Vaud from 6:30 to 20:30 (or 38% of passengers within 24 hours) do so in the morning peak from 6:30 to 9:30 (ibid.).

The positive relationship between trip purpose and intensity of peak hour demand was also observed in the 2011 survey in Geneva and Basel, where the share of respondents during peak hours was higher on lines with frequent work / professional trip purposes (cf. Table A 4, p. 181).

5.2.5 Consequences

The analysed statistics show that from a quantitative point of view, cross-border traffic is not a peripheral phenomenon, but consists of important traffic volumes. Compared to domestic traffic, however, the modal share of public transport is lower, and the shares of trip purposes among passengers are different and vary also according to the country of residence. The observed demand structure as well as the entire passenger potential are widely dependent on local factors and the (attracting) differences between the involved countries.

In Geneva and Basel, the trip purpose ‘work / professional’ is very dominant. Together with the effect of economic gradients at borders, which prevents transport flows from being temporally coincident in both directions, this leads to very distinctive peaks of demand. With approximately 50% of daily demand arising during three consecutive hours, this makes it very difficult and expensive to provide high quality public transport services due to the inefficient use of vehicles and public transport infrastructures. Economic considerations may lead to an insufficient service offer during peak hours (e.g. not enough seats available) that can make choice riders turn away from using public transport.

5.3 Customers’ Perspective

5.3.1 Introduction

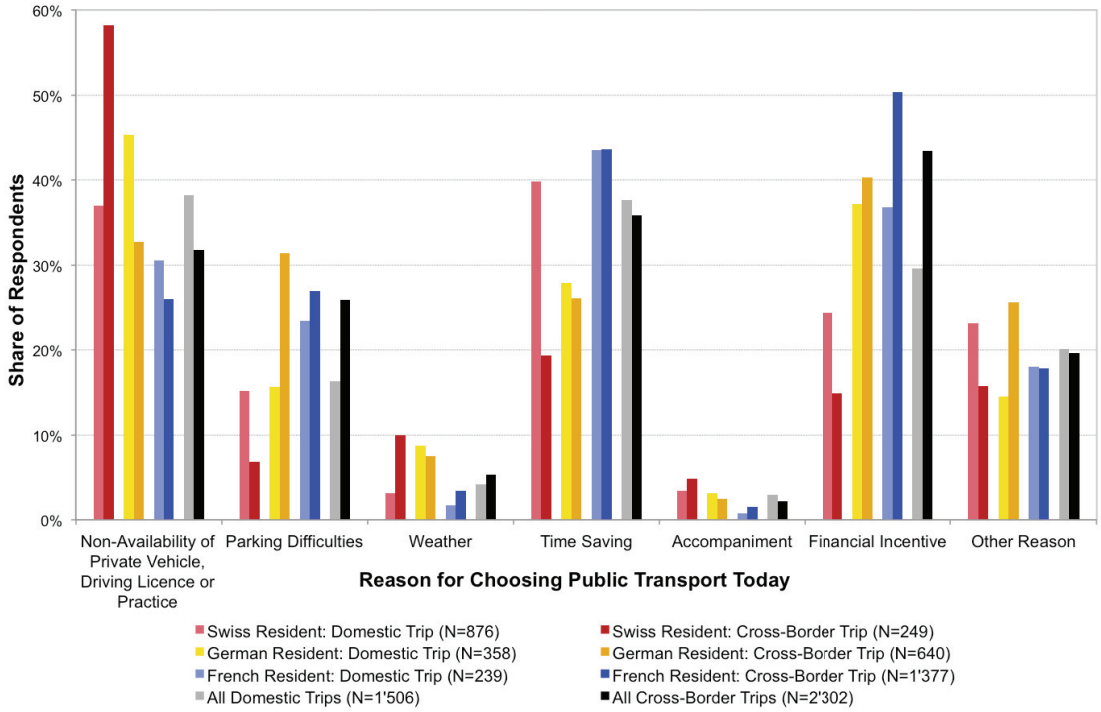
The survey among public transport passengers that has been carried out in the agglomerations of Geneva and Basel in 2011 (see methodology chapter 4.3) aimed at complementing existing statistical data. Therefore, it focused also on the passengers’ perspective of using public transport in order to better understand their behaviour and the reasons behind. The following sections are dedicated to results and findings of this survey.

In the context of the research question of this study, any differences between domestic and cross-border passengers are of special interest. As the shares of residents of different countries vary significantly within the sample of respondents, and since it has been assumed that answers may differ between residents of the involved countries, many results are shown separately for German, French and Swiss residents.

5.3.2 Motivation to Use Local Public Transport

The reasons for using local public transport, rather than other modes, which have been specified by survey respondents may indicate relative strengths and weaknesses of the current public transport system. Overall results are shown in Figure 5-23.

Figure 5-23: Reasons for Using Public Transport by Country of Residence and by Domestic / Cross-Border Journey



Source: Own Survey (2011), cf. chapter 4.3

Among cross-border passengers, the most frequently named motivation are financial considerations (43% of respondents). For domestic passengers, especially for Swiss residents, finances are a somewhat less decisive factor, which makes the second and third most important reasons more decisive for them: time savings (36%) and the non-availability of a private vehicle (including no licence or no practice) (32%).

These time savings are most important among Swiss domestic and French passengers (40% and 44%), and less important for German and cross-border Swiss passengers (27% and 19%).

Instead, for Swiss residents travelling across borders (which represent a small fraction of users), the non-availability of a private vehicle has been named by more than half of the respondents as a reason for using public transport. Accordingly, all other motivations apply to a very limited extent to this passenger group.

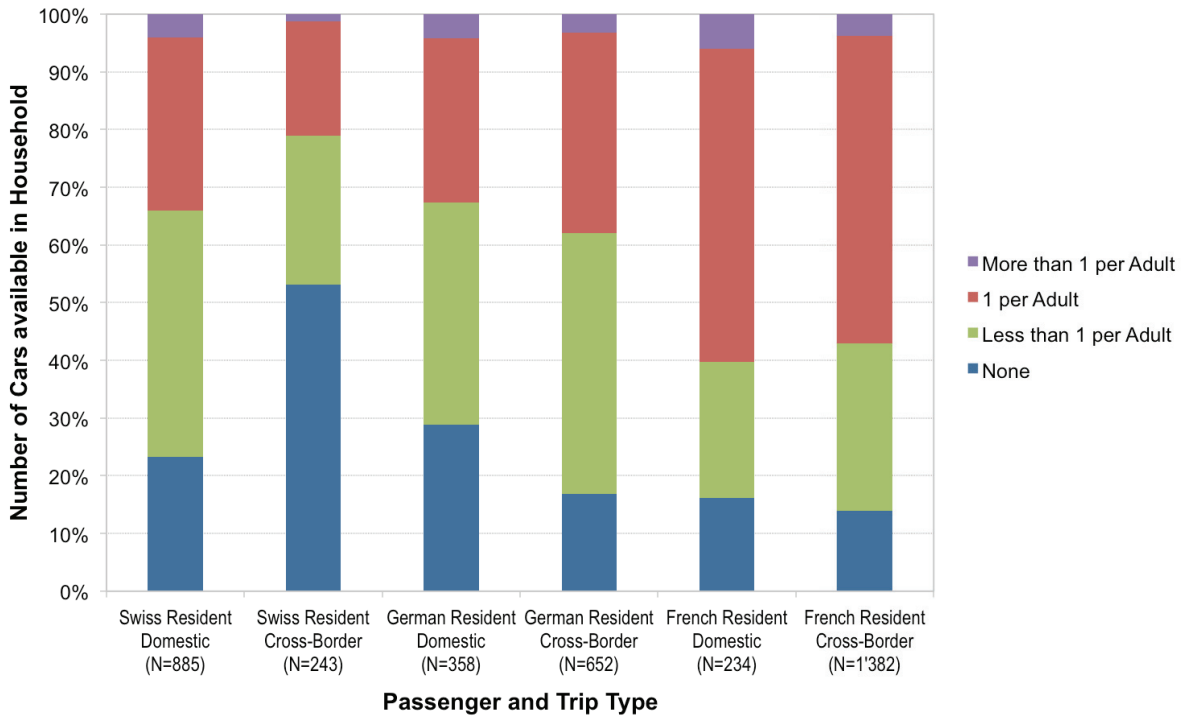
Parking difficulties are a reason for using public transport for around 25% of respondents. This applies to a greater extent to those passenger groups where a private vehicle is available:

As shown in Figure 5-24, the lowest car availability can be found among Swiss residents travelling to France or Germany, followed by German and Swiss residents using domestic public transport. On the other side, car availability among cross-border passengers residing in France or Germany is relatively high, which makes their use of public transport more remarkable.

Accompaniment and Weather issues (the was been carried out in October) are of lesser importance to all passenger groups.

In the category 'other reason', specified motivations were very diverse, with "ecological considerations" and "relaxing" / "de-stress" being named most frequently. Further reasons included "drinking a glass of wine", "travelling in a group" or simply "being used to it".

Figure 5-24: Car Availability by Country of Residence and Cross-Border / Domestic Trip



Source: Own Survey (2011), cf. chapter 4.3

5.3.3 Motivation for Domestic / Cross-Border Trip

5.3.3.1 Introduction

'Shopping' and 'Leisure' have revealed as (still) being a quantitatively less important trip purpose on cross-border lines. Yet, the trip purpose analysis of chapter 5.2.3 might suggest that there is still a potential for such passengers, especially among Swiss residents, which are not (yet) as numerous on cross-border local public transport.

Shopping and leisure are considered as rather flexible trip purposes, for which travel habits may be changed more easily than work purpose trips. Additionally, this passenger potential is of special interest, as it would contribute to a better mix of trip purposes and thus to a better temporal distribution of demand, which would in turn allow a better capacity usage and more efficient operations.

Therefore, the detailed motivations of survey respondents who were using public transport for shopping purposes are analysed in the following sections.

By doing so, it has to be born in mind that these responses only apply to current public transport users, and that additional motivations in favour and against using public transport exist for users of a private vehicle and pedestrians or for people that currently refrain from making such trips.

5.3.3.2 Shopping Trips

5.3.3.2.1 Survey Responses

Figure 5-25 shows the specified reasons why respondents chose to carry out their shopping domestically or abroad, respectively. For Swiss residents – the largest group among cross-border shoppers –, the most important reason for shopping beyond borders are clearly the lower prices with more than three quarters of applicable respondents answering affirmatively to this point.

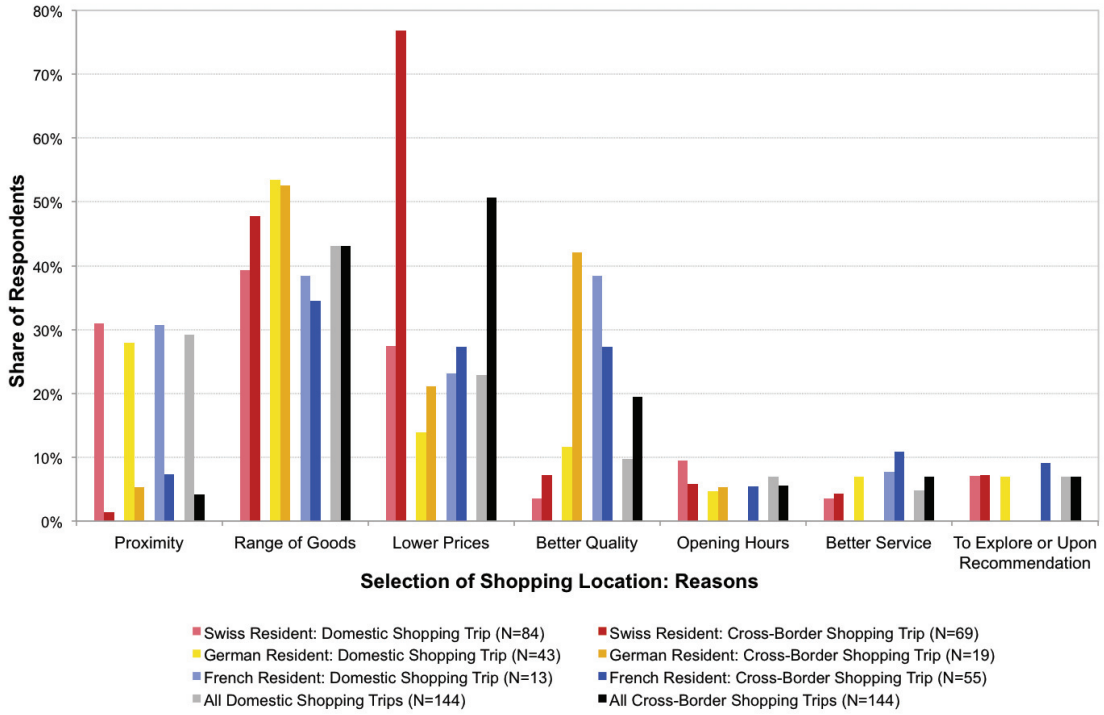
For German residents, better quality and, interestingly, but to a limited extent, lower prices are among the motivations that are more frequently named by cross-border shoppers than by domestic ones.

French residents rarely use cross-border public transport for shopping purposes, as the small number of respondents reveals.

The range of goods is important for the residents of all countries, but applies equally to shopping domestically and abroad.

Proximity is a reason for all respondents to shop in the country of residence, whereas opening hours, service quality and recommendations are all of marginal importance both in the domestic and the cross-border context.

Figure 5-25: Reasons for Crossing or Not Crossing the Border on Shopping Trips by Local Public Transport



Source: Own Survey (2011), cf. chapter 4.3

5.3.3.2.2 Disadvantages of Using Local Public Transport for Shopping Abroad

Today, two key disadvantages can be identified for using cross-border local public transport for shopping purposes:

(a) Cross-border lines are insufficiently integrated into the urban public transport network and enable only a small fraction of the population to reach destinations abroad without changes (cf. chapter 5.1.4.3).
(b) Making use of certain financial advantages, such as fuel tourism or the acquisition of a confirmation by customs officers that allows the refund of value added tax, is more difficult when travelling by public transport.

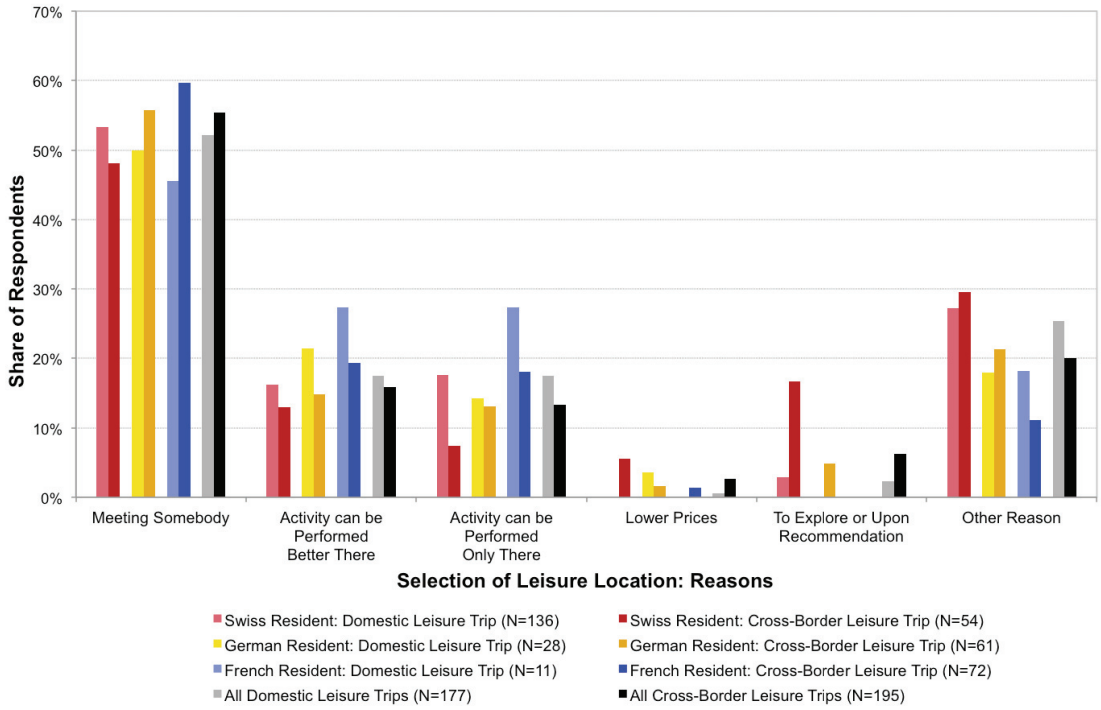
While the second point is of very structural nature, tackling the first point may contribute to exploiting the underused passenger potential of cross-border shoppers.

5.3.3.3 Leisure Trips

5.3.3.3.1 Survey Responses

By analogy with the analysis of shopping trips above, Figure 5-26 shows the reasons revealed by passengers for the selection of their leisure destination, within the border limits or beyond.

Figure 5-26: Reasons for Crossing or Not Crossing the Border on Leisure Trips by Local Public Transport



Source: Own Survey (2011), cf. chapter 4.3

The most frequent motivation for the choice of a specific leisure location is ‘meeting somebody’, which was indicated by more than half of respondents. Far fewer respondents (less than 20%) chose their domestic or foreign location due to better or exclusive possibilities of performing the leisure activity at this place.

Lower prices, exploration and recommendations have been chosen by a small minority of respondents and are apparently of very limited importance.

Within the category ‘other reasons’, respondents often specified hiking tours or the culinary and cultural offer as well as reasons that correspond to one of the already existing categories.

Interestingly, for all motivations, no significant differences between the different respondent types (country of residence and domestic / cross-border trip) could be observed: the same reasons that could motivate crossing the border can equally motivate not to do so.

Yet, the size of the different groups of respondents, and thus the volume of demand is still inhomogeneous: Among domestic travellers, more than three quarters of respondents are Swiss residents (136 out of 177). Using local public transport for leisure activities appears to be unpopular within France and Germany. Among cross-border passengers, however, residents of the three involved countries are far better balanced.

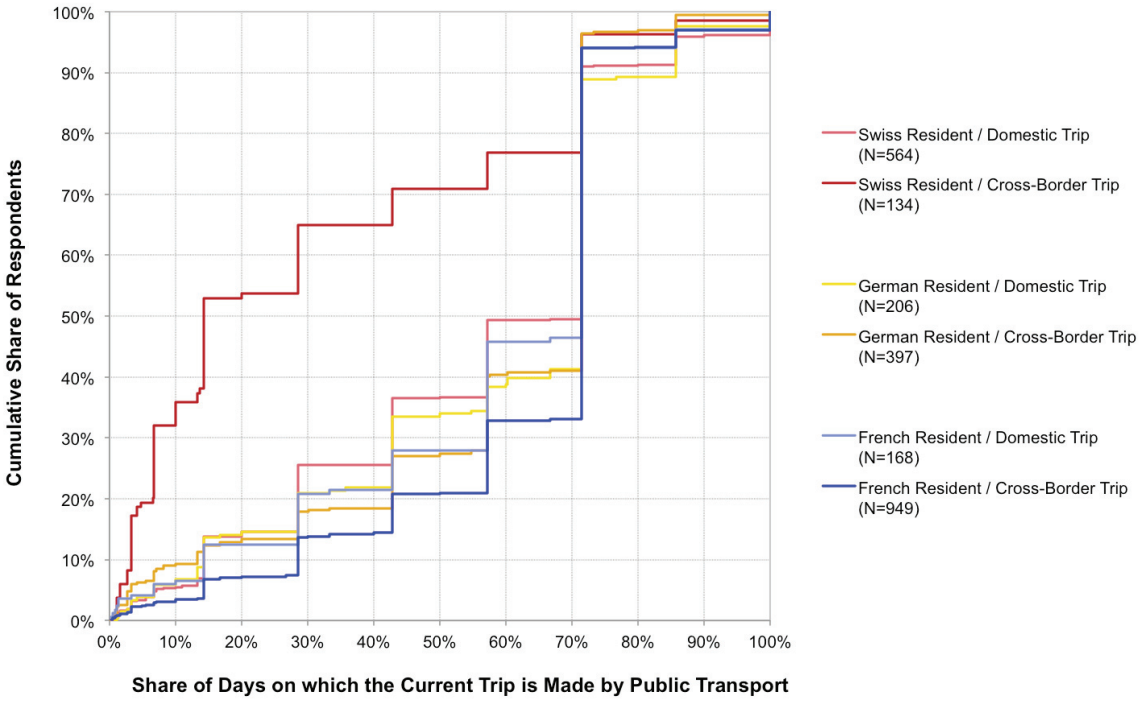
5.3.3.3.2 Disadvantages of Using Local Public Transport for Passing Leisure Abroad

The most important factor to the disadvantage of using cross-border local public transport for leisure activities probably consists in the adaptation of timetables on many lines according to working hours, which results in a weak offer on weekends and evenings, when the potential share of leisure passengers is expected to be higher.

5.3.4 Frequency of Use

The frequency of use of public transport is an important indicator in the analysis of the travel behaviour of passengers. Figure 5-27 reveals the use of public transport for the trip on which the survey was distributed. Responses are shown separately for Swiss, German and French Residents, as well as for domestic and cross-border trips.

Figure 5-27: Passengers' Frequency of Making the Surveyed Trip



Source: Own Survey (2011), cf. chapter 4.3

Figure 5-27 reveals a generally high usage frequency of public transport for the specific surveyed trip: In almost all user groups, between half and two thirds of passengers make the trip at least on five days per week. The only exception are Swiss residents using cross-border transport, among which more than half of respondents make the trip on one day per week or less often, and frequent passengers who make this trip at least five days per week amount to less than a quarter of Swiss cross-border respondents.

This is however well-explicable when recalling that on cross-border trips, the majority of Swiss residents have shopping or leisure as their main trip purposes, whereas most French and German residents use cross-border public transport for work / professional purposes (cf. Figure 5-21). German and French residents are thus not only more numerous on cross-border local public transport lines to Switzerland, but they are also more frequent users of these services.

5.3.5 Satisfaction about Local Public Transport

5.3.5.1 Introduction

Satisfaction about the offer of local public transport can be used as an indicator of the general attractiveness of a service to its customers. In a further step, and by analysing the data in more detail, it may also reflect the propensity of potential users to make use of the public transport service in the future.

Satisfaction criteria can be divided into different categories, and they are typically enquired separately for the different service elements of public transport, but an indication of global satisfaction may also be enquired. However, as the characteristics of service elements may vary from one line to another, it seems sensible to differentiate the answers by the line where the survey was distributed. Therefore, in this section, results are not primarily shown, as above, according to country of residence, but separately for different lines. The distinction between domestic and cross-border passengers, however, remains.

Satisfaction measurements are analysed from two different surveys that have been carried out at a similar time in autumn 2011, but not simultaneously.

The first one by GfK Trustmark (2012) has been commissioned by the cantons of Basel-Landschaft, Basel-Stadt and Solothurn and provides a global comparison of passenger satisfaction between some cross-border lines and Swiss domestic lines within the agglomeration of Basel. Some of the findings from this report are presented in chapter 5.3.5.2.

The second source consists in the own survey that was carried out in the agglomerations of Basel and Geneva, and which has been introduced in chapter 4.3. It has been designed in a complementary way to the first survey, as it does not compare domestic to cross-border lines, but focuses on cross-border lines only. Thereby, the significantly larger sample of respondents on cross-border lines enables cross-border and domestic passengers to be analysed separately. In addition to the comparison between ratings of different lines, this allows the comparison of different passenger groups on the same lines. These results are presented in chapter 5.3.5.3.

5.3.5.2 Comparing Domestic and Cross-Border Lines

The survey by GfK Trustmark (2012), which has been carried out in the agglomeration of Basel compares customer satisfaction of various domestic transport operators (N>4'000) to cross-border bus lines (N=142). Due to the small sample of the latter lines, these have not been further divided, but are regarded globally.

Satisfaction measures have been asked for various elements in comprehensive questionnaires and included categories (each with many elements) including reliability, comfort, information, network quality, tickets, security, personnel etc.

In almost all categories, cross-border bus lines have obtained ratings in the 'satisfactory' range, with the overall satisfaction reaching 68 out of 100 points. However, the cross-border lines have never been rated better than any one of the domestic transport operators, with the only exception of 'riding comfort', where cross-border lines reached an average rating among all considered lines.

While the results of the study are based on subjective responses of passengers, they provide a reflection of the general perception of the quality of services. Apparently, on cross-border bus lines of the agglomeration of Basel, this perceived service quality still seems to be lower. This lower ratings do not have to be ascribed to the respective transport operators only, but also to the contracting authorities that may be responsible e.g. for frequency and duration of services and for prioritisation measures of public transport in urban traffic.

It might, however, also be assumed that cross-border passengers could have different expectations towards public transport services than domestic passengers, and that their responses may have resulted in lower ratings for this reason only. Therefore, a comparison between domestic and cross-border passengers is carried out in the following section. Also, some of the quantifiable elements (service hours, frequency, speed) will be objectively analysed in chapter 6.2.

5.3.5.3 Comparing Domestic and Cross-Border Passengers

5.3.5.3.1 Overview

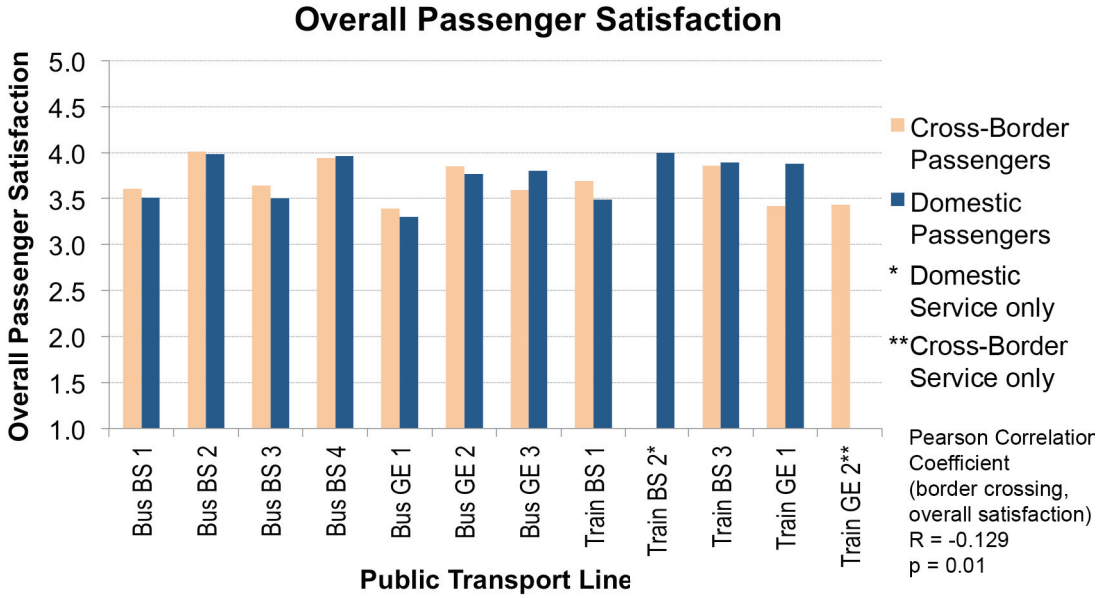
The comparison between the ratings of domestic and cross-border passengers on the same lines can be carried out on the basis of the own passenger survey (cf. chapter 4.3). Here, results are shown separately for overall satisfaction (5.3.5.3.2), satisfaction about fares (5.3.5.3.3) and satisfaction about service hours (5.3.5.3.4).

Satisfaction could be declared by passengers on a scale from 1 (very poor) to 5 (ideal). The graphs in this section show the average response value per line and per passenger group (i.e. domestic or cross-border passenger). For satisfaction with fares and with service hours, these average satisfaction values are compared with the actual fares and service hours that apply to the relevant passenger group. In these analyses, domestic passengers of different countries have been divided to separate passenger groups, as domestic fares and service hours are rarely equal at both sides of borders.

5.3.5.3.2 Overall Satisfaction

Figure 5-28 presents overall passenger satisfaction comparing domestic versus international trips for each route surveyed in the study. It reveals that the overall satisfaction varies somewhat between the different lines, with differences of the mean satisfaction values of up to 0.63. This is not surprising, as the level and quality of service offered on the different lines also varies. However, it is surprising that on almost all lines, cross-border and domestic passengers have made very similar ratings. The only exception is 'Train GE 1', where cross-border services are offered less frequently and with different rolling stock than domestic services. This lead to a low correlation coefficient between the border crossing and overall satisfaction of R = -0.129.

Figure 5-28: Overall Satisfaction of Domestic and Cross-Border Passengers on All Lines



Source: Own Survey (2011), cf. chapter 4.3

5.3.5.3.3 Satisfaction about Passenger Fares

Figure 5-29 compares passenger satisfaction about fares for single journey purchasers. Each public transport line is represented by one to a maximum of three data points (one for cross-border passengers and two for domestic passengers on either side of the border), which represent the average satisfaction values of these groups. In some cases data points with a very small number of respondents have been omitted for reasons of statistical robustness.

The satisfaction values (as dependent variables) are shown together with the actual fare prices for the respective passenger group (as independent variables). These fares represent the actual standard fare required for a 5 km journey of the relevant line and passenger group (cross-border / domestic). Only respondents with single tickets are depicted in Figure 5-29, but season ticket holders reveal a similar trend (not shown). All prices are given in Swiss Francs

(CHF); some of them have been converted from Euros (EUR). CHF 1 has been considered equivalent to EUR 1.20.

Besides the graphical representation of the dependence, the key values of a multiple linear regression model are given at the bottom right-hand corner of the figure. The low R^2 values can partially be explained from the fact that the dependent variable only consists of five possible discrete values (1, 2, 3, 4, 5), which can intrinsically not be very accurately represented by a linear regression model. The significance level p and the standardized correlation coefficient beta, which indicates extent to which an independent variable contributes to the regression estimation, are given for each independent variable.

Figure 5-29: Satisfaction versus Fare (single ticket purchasers)

Source: Own Survey (2011), cf. chapter 4.3

The first thing to notice is that that price levels vary significantly: the price for a 5-km journey single ticket varies from CHF 1.54 to CHF 3.90, the latter being 2.5 times higher than the former. While these differences can arise on one hand from different areas of validity on which the ticket can be used in addition to the 5km trip, they are also a clear expression of the different price levels that apply on either side of the border.

The price levels of the different journey types can be ordered as follows from cheapest to most expensive: France domestic, Germany domestic, Switzerland domestic; Switzerland-Germany cross-border. Interestingly, tickets for journeys between France and Switzerland vary over the entire range, since they sometimes follow the French price levels, but are in other cases fully integrated to Swiss fare systems and thus clearly more expensive (for more details about fares, see chapter 6.3).

The range of satisfaction values of different lines with similar prices and the low R^2 values of the regression models show that price alone can not be the only determinant of satisfaction with price for these trips (a comparison of the price with the quality of service may have occurred instead), even though passengers travelling on sections with lower fares tend to be more satisfied about fares than passengers on expensive services.

Of special interest here, however, is the fact that there is no direct effect of border crossings on price satisfaction as can be seen by the low beta and high p values of the border crossing. Thus, cross-border passengers rate this service element in the same way as domestic passengers, and both passenger groups have the same expectations and standards.

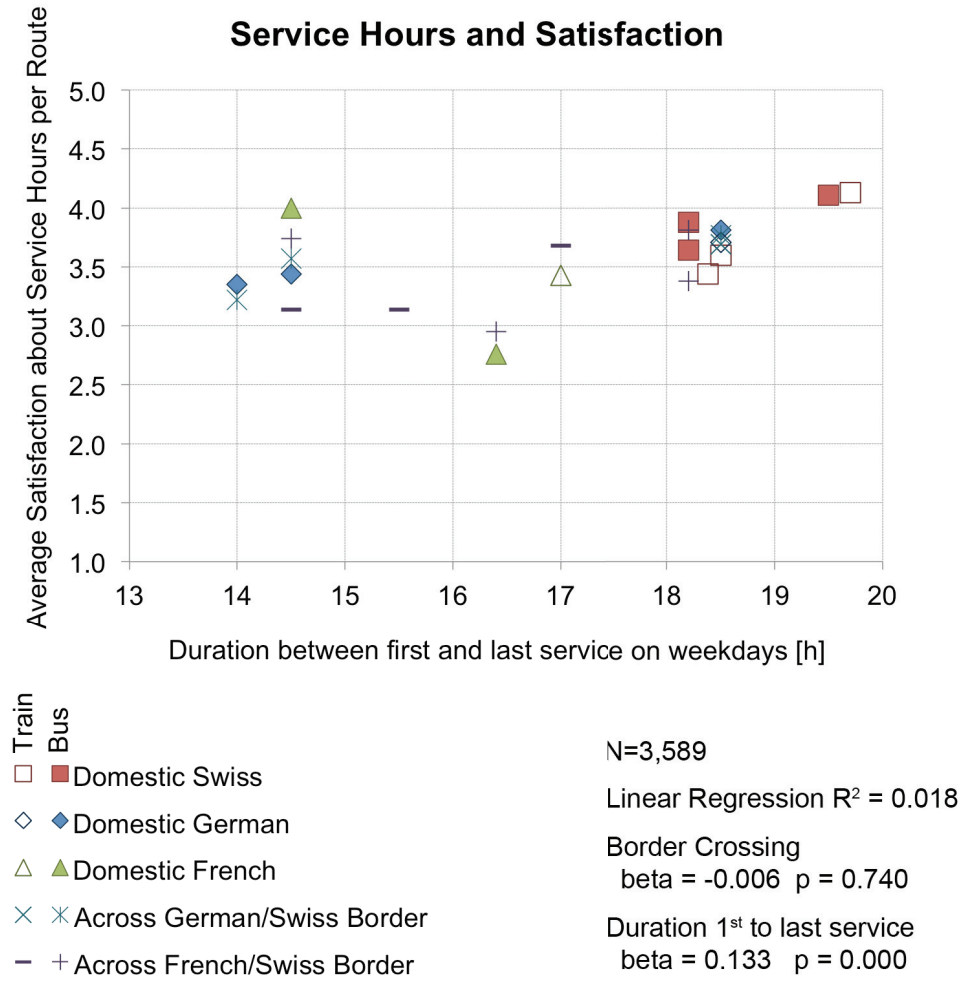
5.3.5.3.4 Satisfaction about Service Hours

Another important element of user satisfaction is operating hours. Figure 5-30 compares user satisfaction with operating hours to actual operating hours by line. As in Figure 5-29, each line is represented by one to three average data points, depending on the existence of up to one cross-border and up to two domestic passenger groups, as well as on whether the number of respondents per passenger group is sufficient for a statistically robust result.

As shown in Figure 5-30, service hours (as the independent variable) vary for buses and trains as well as for domestic and cross-border services equally: all these route types spread from 14 to approximately 19 hours of service hours per day Mondays through Fridays, whereby domestic routes are not generally operated longer than cross-border services (for a more detailed analysis of service hours see chapter 6.2.1).

Within this range, the average passenger satisfaction increases from short to long service hours by about 0.5 points. This applies in the same way to both cross-border and domestic routes, which again demonstrates the very limited effect on satisfaction of the border crossing itself (as compared to the effect of the measurable ‘service hours’ variable and other influencing factors). This is reflected in the beta values for border crossings of -0.006 as compared to 0.133 for actual service hours as well as the respective levels of significance. For the low R^2 value, the same considerations as in 5.3.5.3.3 apply.

Figure 5-30: Satisfaction about Service Hours versus Service Hours



Source: Own Survey (2011), cf. chapter 4.3

5.3.6 Consequences

The analysis of the customers' perspective provides various insights to the motivation of passengers to use public transport. It is a precious complement to the volume-based investigations of the previous sections.

The high car ownership rate among cross-border passengers residing in France and Germany (but not the small minority of Swiss cross-border passengers) reveals the important share of choice riders, i.e. passengers that potentially have another means of transport at their disposal. This entails the risk that these choice riders may be deterred from using public transport if service quality is insufficient.

Yet, on the other hand, service quality of cross-border bus lines in Basel already now obtained an inferior satisfaction rating as compared to domestic services. As it could be shown that the responses of cross-border passengers are not impaired by the existence of the border crossing, and that they have similar expectations to the quality standards of public transport, this lower

service quality appears to be accurate. However, conversely, this gives rise to the assumption that an increase of the quality of service would lead to more people choosing to use local public transport across borders.

This potential applies both to peak hour demand (mostly commuters from Germany and France to Switzerland) where congestion of motorised private transport could be mitigated, but also to leisure and working trips (currently primarily Swiss residents), which would contribute to balancing the very strong demand peaks on cross-border lines and thereby allowing a more efficient use of public transport vehicles and infrastructure.

6 Specific Service Characteristics

6.1 Organisational Structures

6.1.1 Cross-Border Cooperation of Authorities

6.1.1.1 Introduction

Cross-border cooperation between authorities is crucial to co-ordinate activities with repercussions outside the respective area of responsibility. Thus, for planning and organising cross-border public transport, such cross-border cooperation structures are of significant importance.

Cross-border cooperation forms between public authorities can be of various nature. Petzold (2006) structured the different possibilities into three categories:

(a) Ad hoc structures
(b) Networks
(c) Institutionalised cooperation forms.

6.1.1.2 Ad Hoc Structures

Ad hoc structures involve project-based, direct cooperation between neighbouring authorities. While such structures also exist at a national level, i.e. between entire nation states, we focus here on regional and local levels. As an advantage, such structures and projects can be realised at short term, and new, innovative ideas can potentially be implemented quickly.

On the other hand, the realisation of projects depends on complete unanimity among the involved parties and of their will to overcome legal and administrative obstacles. In particular, the distribution of financial contributions needs to be settled and approved by the responsible bodies. Molter (2012) also stresses the importance of temporal horizons: Thinking in different time periods (e.g. planning or financing terms) can thus be a major hindrance for cross-border cooperation. This becomes most evident at the time of elections for one of the involved local or regional authorities. Therefore, cross-border projects based on ad hoc structures risk to be of discontinuous nature.

6.1.1.3 Networks

Cross-border networks are the next stage of formalising cross-border structures. They are likely to embrace more parties than ad hoc structures and usually extend over a regional, rather than a local aThe potential of synergies, access to resources and the possibilities of

dividing responsibilities among network members are of a greater extent than for classic ad hoc structures (Petzold 2006). Also, the fact that competences remain unchanged facilitates the establishment of such networks.

However, the high number of involved parties is likely to decelerate and complicate decision processes. Moreover, cross-border networks usually have no legal capacity and have therefore a restricted scope of action. Typically, their aim consists in the mediation between the involved parties as well as in the elaboration and reconciliation of strategic concepts (Molter 2012).

Networks are, however, unable to finance their own projects; instead they are dependent on the approval of affected members for financial contributions. This is a major drawback for the implementation of projects.

Examples of networks are the Euroregions at the German-Polish and German-Czech borders (Ahrens and Schöne 2008).

6.1.1.4 Institutionalised Cooperation Forms

6.1.1.4.1 Legal Basis

To overcome the drawbacks of ad hoc cooperation and networks, it is possible to establish institutions of cross-border character that can act on behalf of the concerned authorities and that are even able to adopt financial competences. A precondition to their erection is, however, the existence of a legal basis for such institutions that had been previously agreed and ratified by the involved jurisdictional bodies (including the national level) (Ahrens and Schöne 2008).

In Europe, there are currently exist three legal forms for cross-border cooperation that allow the adoption of duties and competences from local and regional authorities of different countries:

(a) **The European Grouping for Territorial Cooperation EGTC** (also known as *Groupement européen de coopération territoriale GECT* or *Europäischer Verbund für territoriale Zusammenarbeit EVTZ*).

It is based on the EC/EU regulations 1082/2006 and 1302/2013 and the national law at the location of its headquarters (European Parliament and Council of the European Union 2006; 2013).

It can be applied at all borders within the European Union. By means of special agreements, it can also be applied at external borders, as long as the headquarters are located within the EU.

Examples of EGTCs include the Eurodistrict Strasbourg-Ortenau and the Eurométropole Lille Kortrijk Tournai.

(b) **The Euroregional Co-operation Grouping ECG** (also known as *Groupement eurorégional de coopération GEC* or *Verbund für euroregionale Zusammenarbeit VEZ*).

It is based on the third protocol of the Council of Europe's Madrid Convention* and the national law at the location of its headquarters (Council of Europe 2009).

It can be applied in all countries having ratified the third protocol of the Madrid Convention*, which include as of 28.05.2014: Cyprus, France, Germany, Slovenia, Switzerland and Ukraine; further 7 countries have signed but not yet ratified the protocol (Council of Europe 2009).

The Council of Europe's EGC has many similarities to the EU's EGTC but can be realised in other areas; yet, by December 2013, no ECG has been established so far (Mission Opérationelle Transfrontalière 2013).

* The Madrid Convention is officially designated as the "European Outline Convention on Transfrontier Co-operation between Territorial Communities or Authorities concerning Euroregional Co-operation Groupings (ECGs)"

(c) The Local Grouping of Cross-Border Cooperation (originally designated as ***Groupement Local de Coopération Transfrontalière GLCT*** or *Grenzüberschreitender örtlicher Zweckverband GöZ*).

It is based on the Karlsruhe Agreement of 1996 for the borders between France, Luxembourg, Germany and Switzerland and on the Brussels Agreement of 2002 for the French-Belgian border. The earlier, not entirely identical Anholter Agreement of 1991 applies to the German-Dutch border (Schweizerischer Bundesrat et al. 1996; Niedobitek 2001; Ahrens and Schöne 2008; Mission Opérationelle Transfrontalière 2013).

It can be applied in borderlands, where the above-mentioned countries have a common border, for the adoption of tasks and services that are in the interest on either side of the border (Gutt 1999).

6.1.1.4.2 Devolution of Competences and of Operational Duties

An obstacle to the foundation of institutionalised cooperation forms may consist in the need to define duties and competences that can be devolved from the local and regional bodies to the new cross-border institution. In case of the GLCT, its "budgetary autonomy", as mentioned in its legal basis, may cause additional controversy (Gutt 1999).

On the other hand, these factors can indeed be the strength of such cross-border institutions. In the majority of cases, however, the devolved competences are still of supporting, project-based nature mainly for strategic duties, rather than operational duties, such as the planning and financing of public transport services, although these competences could be transferred as well.

A rare example where a cross-border institution adopts operational tasks in terms of local public transport can be found in Geneva, where since 2007, the 'Groupement Local de cooperation transfrontalière (GLCT) des Transports Publics Transfrontaliers', within its area of competence, plans, coordinates and develops the offer of cross-border public transport services. It is closely linked to the *'comité stratégique'*, in which the involved local and regional authorities deal with the strategic development of public transport within the cross-border agglomeration of Geneva. The GLCT, for his part, implements these strategies and is notably in charge of operational aspects for cross-border bus lines, such as fares, tendering and performance mandates (Mission Opérationelle Transfrontalière et al. 2006; Zellweger 2008; Stucki 2010; GLCT des Transports Publics 2012).

This GLCT is also responsible for the agreement among authorities on division modalities of their (subsidising / contracting) costs. Similar to the joint financing of public transport services by different Swiss cantons, this cost distribution has been harmonised and is calculated by a predefined formula that includes the territorial proportion of line length and vehicle hours per country (GLCT des Transports Publics 2012).

The devolution of these duties from several authorities (2 cantons, 1 région, 2 départements and 3 communities of communes) to a cross-border institution is unique and, in particular, has enabled the introduction of an integrated cross-border fare area in the cross-border agglomeration of Geneva (cf. 6.3.1.2) (Mission Opérationelle Transfrontalière 2014).

In Basel, as an instance of an agglomeration without GLCT or similar institution, however, the distribution of costs among authorities is determined separately for each line. Instead of the standardised calculation, other factors may become involved, such the interest of the respective authorities in the existence of a certain line. An example from the agglomeration of Basel consists in line 8 of the French operator Distribus, which penetrates 2.3 km into Switzerland, and is also open to Swiss domestic traffic, but no subsidies are paid by Swiss authorities.

Furthermore, complications can arise if the service offer is to be enhanced on a certain line, involving higher payments by authorities from both sides of the border: In the case of bus line 38 (Basel), planned frequency enhancements for December 2013 had to be limited to Swiss section (up to the border crossing) since the German authorities cancelled their additional contributions at short notice (Wahl 2014). Yet, in the case of the bus lines 3 and 4 (Basel), costs for service frequency enhancements (that more than doubled over the years) were taken over entirely by the French side over several years, since it had been refused in 1986 to adjust the Swiss financial contribution (Houbart et al. 2002).

Against this background, Derrer and Thummel (2009) have proposed a structure of a possible GLCT for Public Transport for the case of Basel. Yet, no implementation efforts have been undertaken so far. Instead, motions for establishing a EGTC or a cross-border fare area, which were proposed by members of the cantonal parliament of Basel-Stadt, were considered by the government as inexpedient and have not been further pursued (Regierungsrat des Kantons Basel-Stadt 2011a; 2013b).

6.1.2 Cross-Border Cooperation of Transport Operator Companies

6.1.2.1 Overview

Apart from cooperation between authorities, cooperation between operators can in many cases alleviate the challenges of operating cross-border services. The following organisational setups can be distinguished for the operation of cross-border services:

(a) Service provision by one single operator
(b) Service provision by cooperating operators
(c) Connections with transfers at borders

These operational setups are summarised in Table 6-1 and are further described in the following sections.

Table 6-1: Operational Setups of Cross-Border Services

	Authority		Contractor		Operator	
Country	A	B	A	B	A	B
Single operator	α	β	X	X	X	X
Cooperation (performance-based)	α	β	X	Y	X and Y	X and Y
Cooperation (financial / subcontr.)	α	β	X	Y	X or Y or Z	X or Y or Z
Transfer at Border	α	β	X	Y	X	Y

A, B = Countries
α, β = Authorities
X, Y, Z = Companies

6.1.2.2 Service Provision by One Single Operator

The simplest organisational setup of a cross-border line consists in the provision by one single operator. Ideally, this also includes cabotage, i.e. the carriage not only of cross-border passengers and domestic passengers within the country of the operator's establishment, but also domestic passengers in other countries.

A single operator, in order to operate a cross-border line, has to overcome the following obstacles:

(a) Meeting technical standards and legal requirements for vehicles and personnel: this applies to buses, but to a much greater extent to railways, where technical standards for engines and rolling stock and legal requirements vary widely (cf. chapter 2.3.7.1)

(b) Licensing for entering the foreign domestic transport market: For railways, domestic transport markets in the EU are not yet liberalised; this might in future be achieved by the European Commission's 4th railway package. However, this package, especially its 'market pillar', is highly controversial, and at the time of writing, it is not clear whether it may be withdrawn or postponed to a possible 5th railway package (Jackson 2014). For buses, on the other hand, domestic markets have been opened by EC regulation 1073/2009, and are now accessible to all bus operators within the EU (European Parliament and Council of the European Union 2009).

(c) Contracting with local authorities: As most local public transport lines are dependent on public subsidies, these services need to be contracted with local authorities. Contracts may be awarded to operators directly or by public tendering. With the exception of Geneva – where contracts for cross-border lines are issued by a dedicated institution (cf. GLCT in 6.1.1.4) – a special organisational framework has to be arranged in each case where multiple authorities mutually finance public transport lines. Where a line only marginally extends across a border, no financial contributions are usually granted by the authority beyond the border. Furthermore, observations suggest that authorities may still tend to be reluctant to award contracts to foreign operators.

(d) Organising the integration into the local public transport market and network: Arrangements have to be made in order to be able to use of infrastructures (e.g. control systems, bus stops, turning and waiting areas), to be integrated into fare systems (incl. ticket distribution and revenue allocation), and where necessary to coordinate timetables.

When the preconditions (a) and (b) could be overcome, then the complications (c) and (d) often cause cross-border lines not to penetrate far into the other country, but to end soon after the border crossing, usually at the first location where a transfer to a domestic line is possible. An example are the German bus lines 6 and 16, which penetrate for a few stops into the Swiss part of Basel agglomeration, but does not receive subsidies from Swiss authorities, and have only recently started accepting Swiss domestic fares for journeys within Switzerland (Regierungsrat des Kantons Basel-Stadt 2011b; 2013a). Other examples include the bus lines 4, K and Z in Geneva agglomeration: Each line serves only one bus stop in France; therefore, they are not confronted with cabotage issues and can be operated by operator TPG alone (GLCT des Transports Publics 2012).

Owing to factor (b), cross-border railway lines are only rarely operated by a single operator. Exceptions are possible only on the basis of international treaties and agreements that usually allow operations up to the first station after the border crossing, or transit traffic in special topological situations (e.g. in the case of the German Railway Station on Swiss Grounds of Basel Agglomeration (Freiherr von Berckheim and Bischoff 1852)).

6.1.2.3 Service Provision by Cooperating Operators

6.1.2.3.1 Motivation

Apart from technical standards and legal requirements for vehicles and personnel (point (a) of the previous chapter), the provision of a cross-border line can be simplified by a cooperation of two transport operators from either side of the border. Each operator holds the line license for the section in his country, and holds the entire responsibility for this part (points (b) to (d) of the previous chapter). This facilitates the process inasmuch as existing structures can be used: the operators are familiar with the respective transport authorities, infrastructures, the public transport offer as well as with customer needs. Also, possible competition issues between can be prevented, and conscious or unconscious prejudices or animosities by all involved parties can at least be mitigated.

To operate the two line sections as a through cross-border line, the operators have two options:

(i) Performance-based compensation
(ii) Financial compensation / subcontracting (to partner or subsidiary company)

6.1.2.3.2 Cooperation with Performance-Based Compensation

In the first (rarer) case, buses or trains of both operators are running. The services provided by one operator on the foreign line section are compensated in kind, i.e. by the same amount of vehicle-kilometres or vehicle hours of the other operator on the first operator's line section. This may be combined with financial compensation, if exact performance-based compensation is inexpedient or not possible, or if profitability ratios differ between the two countries. Examples of this model can be found in the agglomeration of Basel with bus lines 38 (cooperation between BVB and Südbadenbus GmbH) and 55 (BVB and SWEG).

6.1.2.3.3 Cooperation with Financial Compensation / Subcontracting

The second case, subcontracting, is more frequent. In this case, only vehicles of one operator are used. This is the standard model for cross-border rail lines, but it is also common among cross-border bus services. In the case of buses, drivers of only one company are usually involved, while this is not necessarily the case for railways. Both bus and railway lines, however, often still terminate close to borders, where they connect to domestic services (cf. 5.1.2.2).

For buses, operations may also be subcontracted to neither of the two partner operators, but to a third company, as it is the case for many cross-border bus lines in Geneva: TPG, the urban public transport operator in the Swiss agglomeration part has founded a subsidiary company, TPG Sàrl in France in order to allow cabotage in France; while the latter does not own proper vehicles, operations of cross-border lines are subcontracted to other, local French bus companies that run vehicles in TPG livery (Houbart et al. 2002; TPG 2011; GLCT des Transports Publics 2012).

These subcontracts have the advantageous side effect from a provider's perspective that use can be made from lower wage levels in France as compared to Switzerland.

6.1.2.4 Connections with transfers at borders

A solution that renounces most of the above difficulties can be achieved with the connection of two domestic lines that stop (and perhaps terminate) next to both sides of a border crossing. For connections with mediocre demand volumes, or for test services of new connections, this may be a very efficient means to establish cross-border connections with a small amount of legal and organisational obstacles.

In this case, where vehicles do not cross borders, it is however even more important to clearly communicate the existence of the connection: information on timetables, fares and stopping locations are crucial to attract customers. Also, coordinated departure and arrival times, and possibly even through fares could further raise the attractiveness of such connections.

A fine example is the 'Moillesulaz' border crossing in Geneva agglomeration that is crossed on foot by more than 5'000 people per day and direction. On the Swiss side, the tramway (used by 77% of border-crossing pedestrians) terminates adjacent to the border, while different French bus lines (used by 17% of border-crossing pedestrians) stop at the French side of the border station (Citec Ingénieurs Conseils SA 2012). Few bus services also cross the border without the need for passengers to cross the border on foot. A similar case exists at 'Riehen Grenze' in the Basel agglomeration.

6.2 Quantity and Quality of Services

6.2.1 Service Quantity

6.2.1.1 Relevance of Service Quantity

The number of offered services, given by the headway and service hours, is for customers and potential customers one of the most important characteristics of public transport services (cf. sensitivities in Table 2-9, p. 40). Therefore, these indicators have been deemed as suitable for the comparison of domestic and cross-border services in this study.

As formulated in research interest R 4, service hours and frequency of cross-border lines may differ from domestic ones. Two types of service quantity analyses are carried out: First, the number of services is observed on a per-line basis, including a comparison of the years 1994 and 2014. Subsequently, service quantity is analysed on a per-stop basis, revealing the spatial distribution of service quantity, as well as the coverage of population within the catchment areas of these public transport stops.

6.2.1.2 Service Quantity per Line

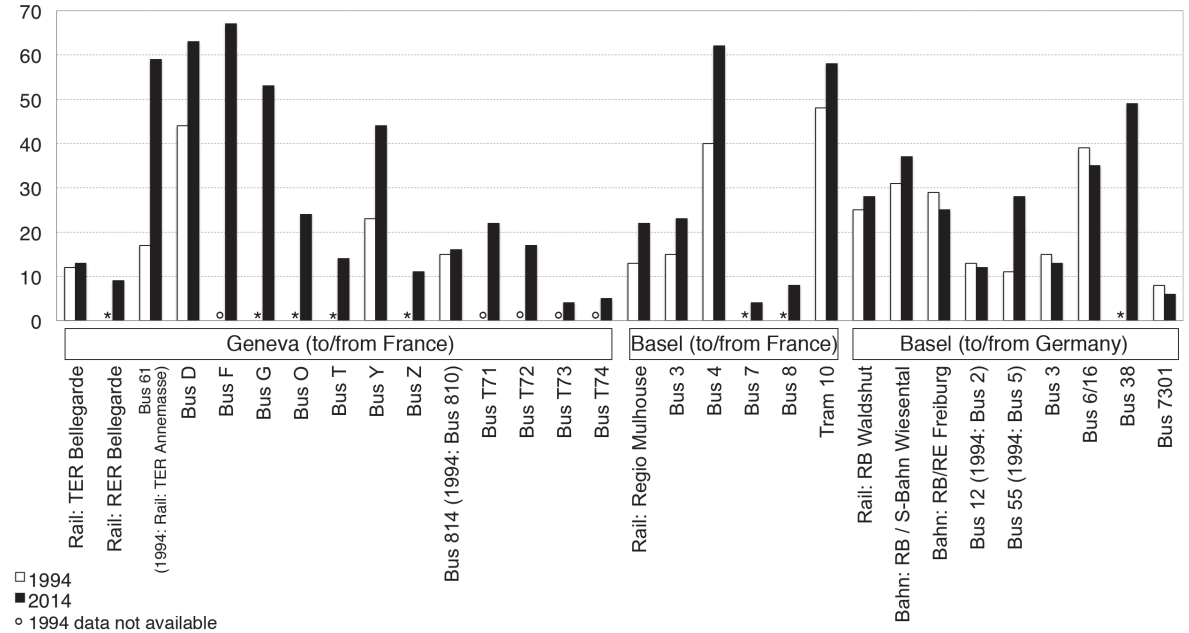
Figure 6-1 provides an overview of service quantity on cross-border routes of local public transport in Geneva and Basel agglomeration for both 2014 and summer 1994.

In 2014, public transport services across borders of either agglomeration are served on approximately 15 lines each, if services on demand, lines with less than 4 return services per day and lines extending less than 1 km beyond borders are excluded from consideration. While this might appear as a substantial amount of services, a consideration of the actual number of services on these lines relativises this impression: on only one third of the considered lines, 30 or more return services per day are operated, corresponding, for example, to a 30 min headway during 15 hours. Furthermore, for both agglomerations together, only three lines have more than 60 return services, standing e.g. for a 15 min headway during 15 hours.

In contrast to domestic lines in comparable distance from the agglomeration centre (not shown in graphs), the cross-border routes are quantitatively on a very low service level: In Geneva and Basel, domestic local rail (S-Bahn) lines run between 40 and 50 return services, and buses mostly between 50 and 130 return services.

Thus, a clear difference between domestic and cross-border service quantities can be observed.

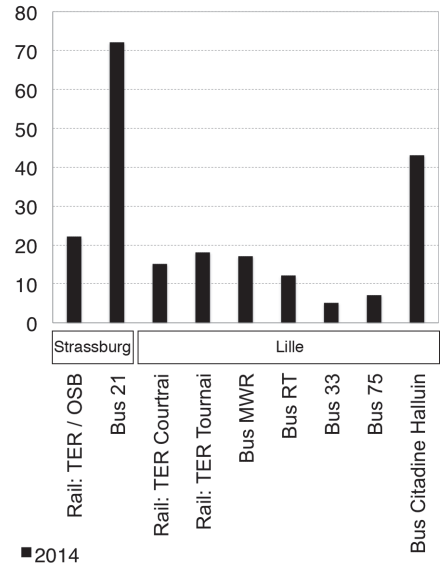
Figure 6-1: Number of Cross-Border Return Services per Day and Line in Basel and Geneva, 1994 and 2014, Mondays to Fridays



Services on demand, lines with less than 4 return services per day and lines extending less than 1 km beyond borders are not shown here.

Data source: transport operators' timeables

Figure 6-2: Number of Cross-Border Return Services per Day and Line in Lille and Strasbourg, 2014, Mondays to Fridays



Services on demand, lines with less than 4 return services per day and lines extending less than 1 km beyond borders are not shown here.

Data source: transport operators' timeables

Comparing the 2014 values of Geneva and Basel to the local cross-border services in Strasbourg and Lille agglomerations (Figure 6-2), similar service levels can be observed in all agglomerations. However, the number of public transport lines extending across borders is much lower in Strasbourg and Lille.

In Strasbourg, this is mostly due to the weaker cross-border transport infrastructure (one rail bridge and two road bridges only). Yet, in Lille, the even topography and wide settlement structures make it difficult to canalise public transport demand to high usage corridors, resulting in a multitude of lines with few traffic, some of which with no more than a handful of departures per day.

Another interesting aspect emerges from comparing quantitative service levels in 1994 and 2014, as shown in Figure 6-1 for Geneva and Basel: In some cases, the number of services has not changed considerably, while on other lines, clear service augmentations can be observed. Eight lines in total had not even existed in 1994 and were created during this 20 years' period, contributing to important service enhancements. The number of services, however, is still rather modest on most of these lines.

Additional cross-border connections exist in all considered agglomeration by interchanging between domestic bus or tramway lines that terminate at the border, and by crossing the border on foot. Any systematic coordination of timetables for such connections, or signalisations between the terminus stops at either side of borders, can not be observed so far. The use of such connections is thus reserved to passengers with advanced knowledge of the local public transport system.

The spatial distribution of stops with cross-border departures is also noteworthy: These are mainly concentrated next to the international borders and along the main axes in the French and German parts of the agglomeration. Other stops in France and Germany, which are served by domestic lines only, have generally low quantitative service levels and are thus apparently of inferior importance.

In the Swiss part, cross-border departures occur only between the border and the city centre of Basel, while all areas south of Basel are barely served by direct connections to the French and

German parts of the agglomeration. The only discernible exception on the graph is the U-shaped tramway line 10, extending on two axes southwards from the agglomeration centre, crossing the Swiss-French border at the south-western extremity of the agglomeration perimeter, and therefore, however, serving predominantly domestic purposes (on the 37 departures of this line between 6h and 20h, PTV France (2012) have counted only 116 cross-border passengers). For this reason, connections between the Swiss agglomeration areas (apart from the agglomeration centre) and French or German parts of the agglomeration require in most cases at least one interchange.

6.2.1.3 Spatial Distribution of Service Quantity

6.2.1.3.1 Introduction

A more detailed insight into the spatial extent of service quantity is possible with the help of Geographic Information Systems. For this purpose, the total number of departures per day has been added for all public transport stops within the agglomeration of Geneva and Basel. These quantities are displayed by colour shades within the catchment area of public transport stops (radius 750 m for railways, 300 m for buses and tramways); the yellow patterns overlaying these shades additionally display the number of cross-border departures as a subset of the total number of departures.

The number of departure values are shown in separate maps for Mondays-Fridays (Figure 6-3 and Figure 6-5), and Sundays (Figure 6-7 and Figure 6-9). Saturdays appear similar to Mondays-Fridays and are thus displayed in the appendix only (Figure A 1 and Figure A 3, pp. 186-187). Additional maps display service duration for Mondays-Thursdays (Figure 6-11 and Figure 6-13). Fridays to Sundays are not displayed since it is assumed that service duration follows other principles on these days.

The graphs displayed underneath each of the GIS maps complement the spatial information of service quantities by the share of the agglomerations' populations being served by the respective quantity of services. These graphs as well distinguish between cross-border and domestic services, allowing for comparisons between these two types of transport services.

Figure 6-3: Spatial Distribution of Service Quantity, Basel Agglomeration (M-F)

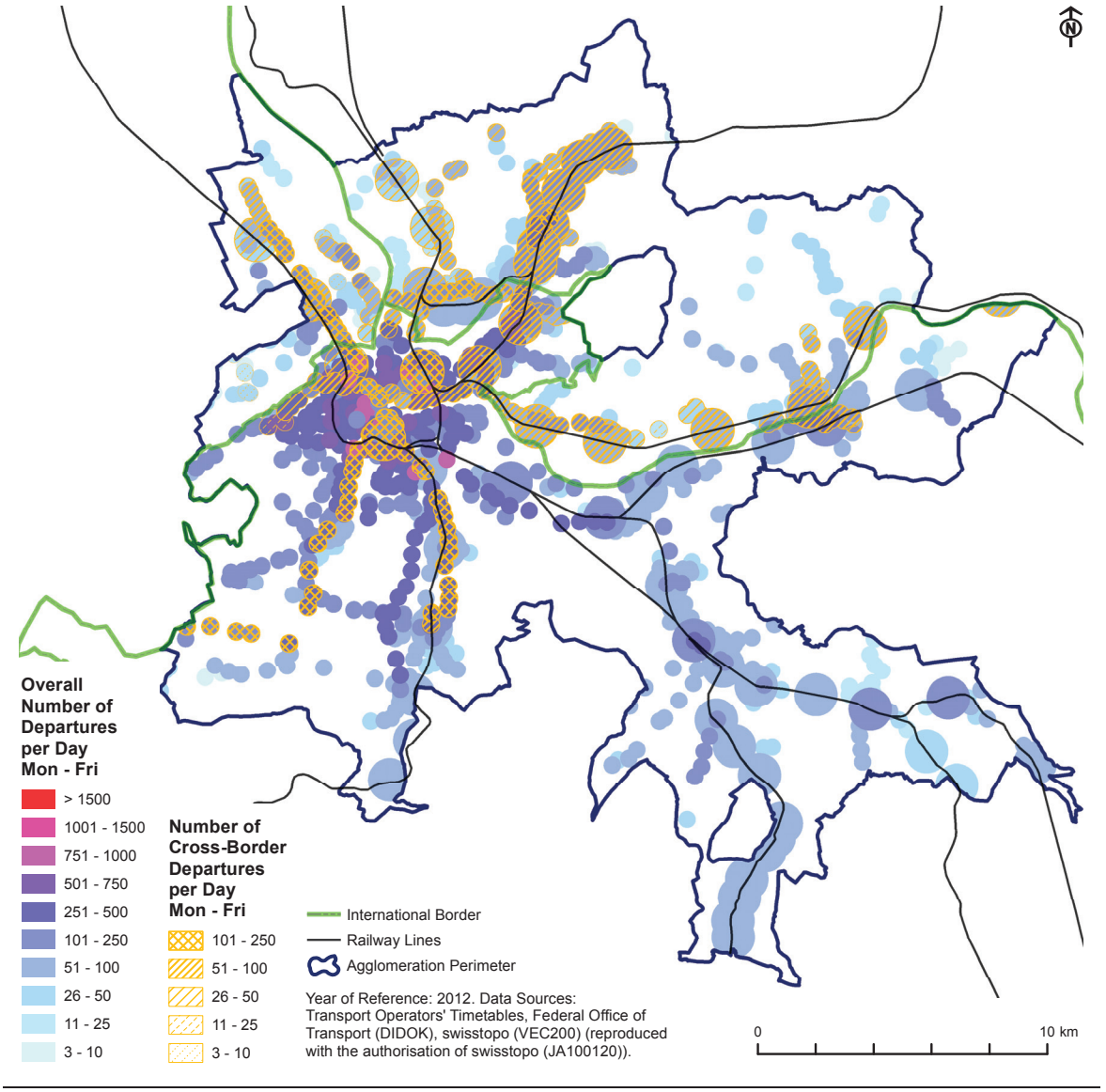
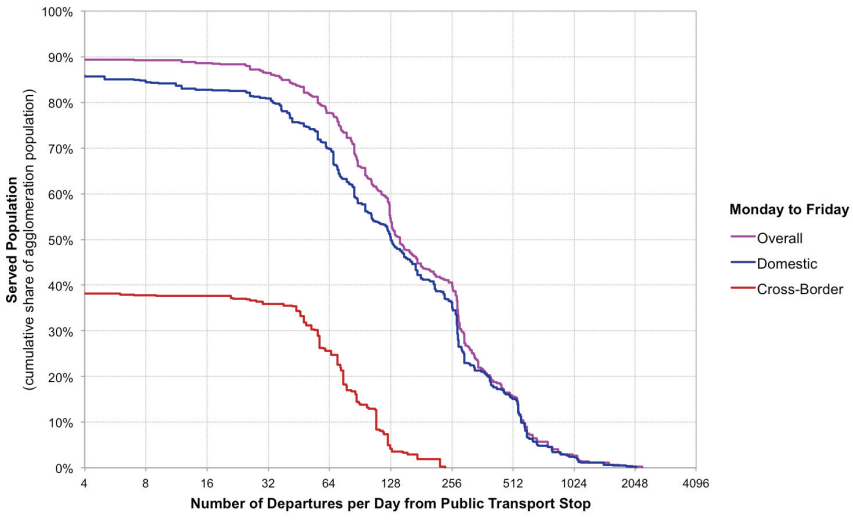


Figure 6-4: Served Population by Service Quantity, Basel Agglomeration (M-F)



Share of Population [%] within Reach of Public Transport Stops

	Cross-Border Services	Domestic Services	All Services
≥ 3 departures	38	86	89
≥ 48 departures	33	75	83
≥ 128 departures	4	51	55
≥ 256 departures	0	36	41
≥ 512 departures	0	15	16

Figure 6-5: Spatial Distribution of Service Quantity, Geneva Agglomeration (M-F)

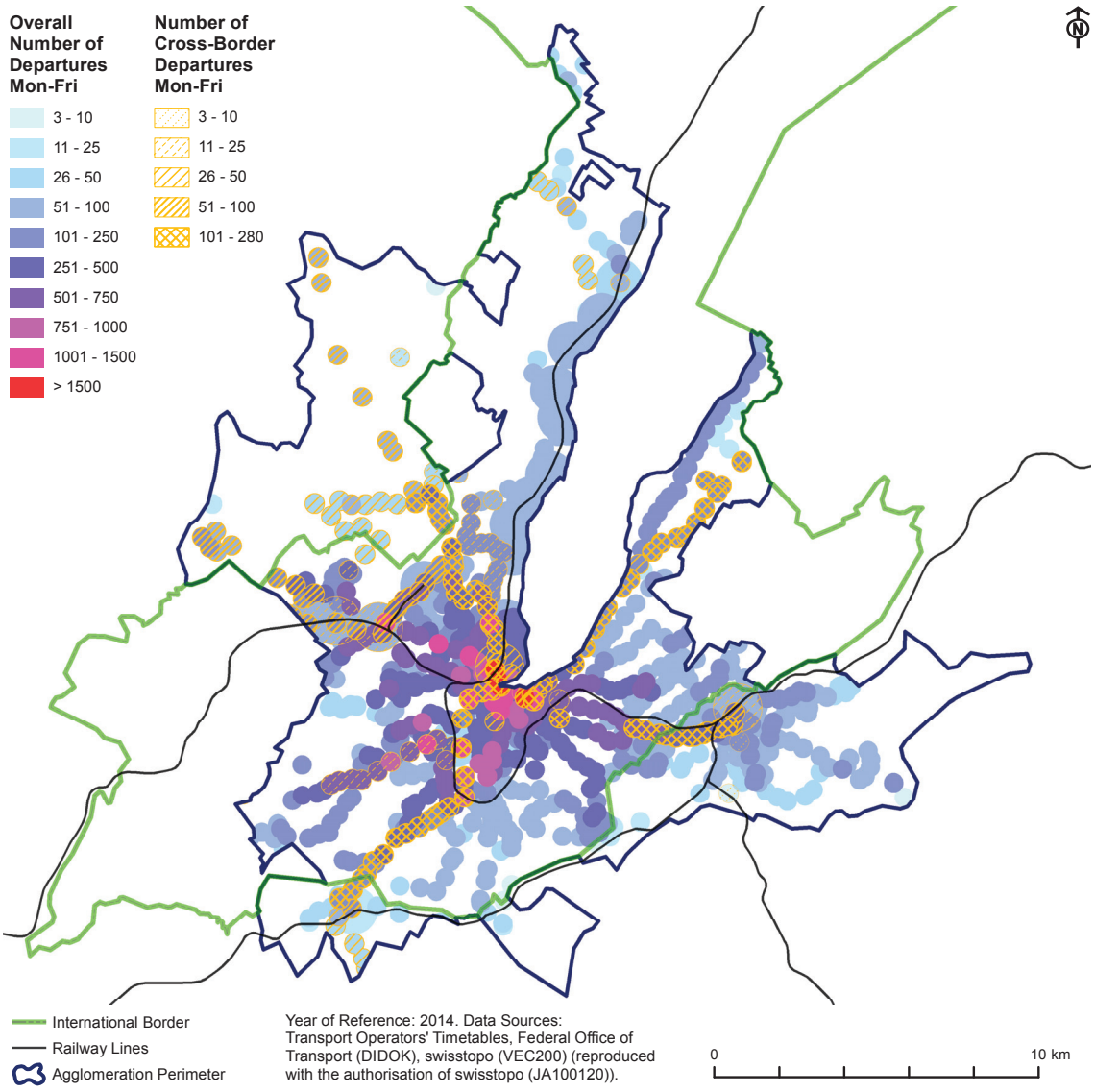
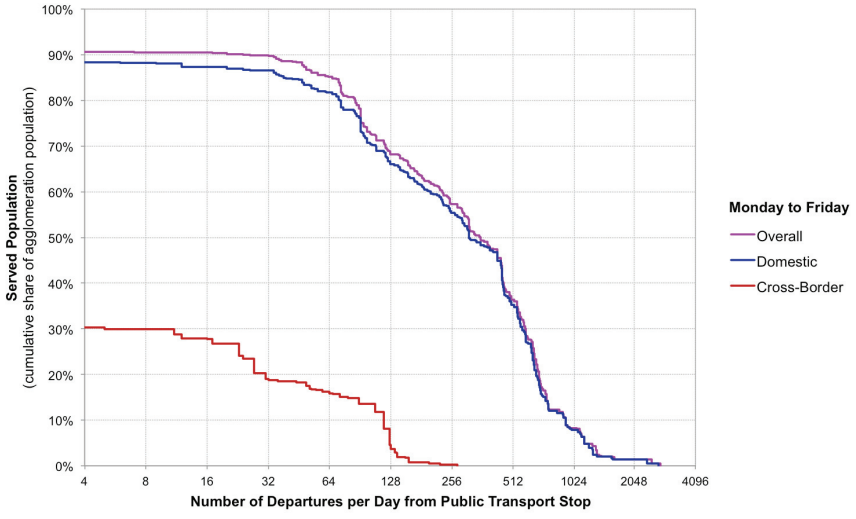


Figure 6-6: Served Population by Service Quantity, Geneva Agglomeration (M-F)



Share of Population [%] within Reach of Public Transport Stops

	Cross-Border Services	Domestic Services	All Services
≥ 3 departures	30	88	91
≥ 48 departures	18	84	88
≥ 128 departures	5	66	68
≥ 256 departures	0	55	57
≥ 512 departures	0	35	36

6.2.1.3.2 Spatial Distribution in Basel Agglomeration on Mondays to Fridays

In the case of Basel, on Mondays to Fridays, the areas with the highest service density extend similarly to the star-shaped agglomeration structure (railways follow this pattern too). In between these axes, in areas with topographically more difficult accessibility, fewer departures can be found. This, however, also corresponds to lower settlement densities and the accordingly reduced demand potential.

Regarding cross-border transport, it should first be noted that no symbol had to be created for public transport stops with more than 250 cross-border departures per workday, because service quantities in this range do not exist at any stop. This is in strong contrast to the overall number of departures from transport stops (i.e. domestic and cross-border services together), which can reach at certain stops 2'000 or more departures per day Mondays to Fridays, such as at the central node of Basel Schifflände (whereof the 4 cross-border bus lines from this stop make up only 147 departures).

6.2.1.3.3 Coverage of the Population in Basel Agglomeration on Mondays to Fridays

The extensive white areas on service quantity maps, representing areas without public transport service and presumably lower population densities, raise the question of the extent to which the agglomeration's population is actually served by local public transport, both on a general level, and also by cross-border services. To this end, the relationship between service quantity and the share of the served population is shown in the graphs underneath the maps.

As already identified in chapter 5.1.4.3 (Figure 5-18, p. 91), 89% of the agglomeration's population resides within reach of a public transport stop, but only 39% within the reach of a stop with cross-border services.

Figure 6-4 additionally reveals the following: the share of the agglomeration's population living near a stop with 128 or more departures per day (Mon-Fri) amounts to 55% if all services are taken into account. If only domestic departures are counted, the population share equals 51%. Yet, if only cross-border departures are considered, only 4% of the population results.

The three displayed curves (for all services, for domestic only and for cross-border only) show the course of the served population shares in dependence of the level of service quantity (minimum number of departures per day). The curves thereby show that cross border departure quantities are systematically lower.

Also, medium and high quantitative services levels of cross-border services are not offered from any stop throughout the agglomeration. This disparity would graphically appear even stronger if a linear scale had been applied on the x-axis of Figure 6-4.

6.2.1.3.4 Spatial Distribution in Geneva Agglomeration on Mondays to Fridays

In Geneva, similar, but not identical, observations can be made: The current network of cross-border railways is almost non-existent, but this is due to change with the above-mentioned opening of the 'RER franco-valdo-genevois' scheduled for 2017.

For buses, the share of the population that can be reached by cross-border services is also very low, especially regarding stops with more than 128 cross-border departures per day.

Due to the compact settlement structure within the agglomeration perimeter, supported by the topographically limiting mountain ranges in the north-east (Jura) and south (Salève), and Lake Geneva from the north-northeast, extensive areas of the agglomerations are well served by public transport. Cross-border services, however, are again limited to certain corridors, with the south-eastern part of the agglomeration, Annemasse, currently being served across borders to a very limited extent only, in spite of its rather dense settlement structure that is seamlessly connected to the agglomeration centre. The 'RER franco-valdo-genevois' will partially alleviate this lack by new connections between rail stations, for the primary benefit of directly surrounding areas.

6.2.1.3.5 Coverage of the Population in Geneva Agglomeration on Mondays to Fridays

The share of residents living within the catchment area of a public transport stop with cross-border services is even lower in Geneva: 30% of the population if all stops with cross-border services are taken into account, and only 18% for stops with more than 48 cross-border departures. If, for a comparison, not only cross-border, but also domestic departures are taken into account, the population shares reach values as high as 91% and 88% respectively.

Therefore, it applies also to the agglomeration of Geneva that cross-border journeys without interchanges to connecting domestic services are therefore rarely possible, and require the attentive observation of timetables.

Figure 6-7: Spatial Distribution of Service Quantity, Basel Agglomeration (Sun)

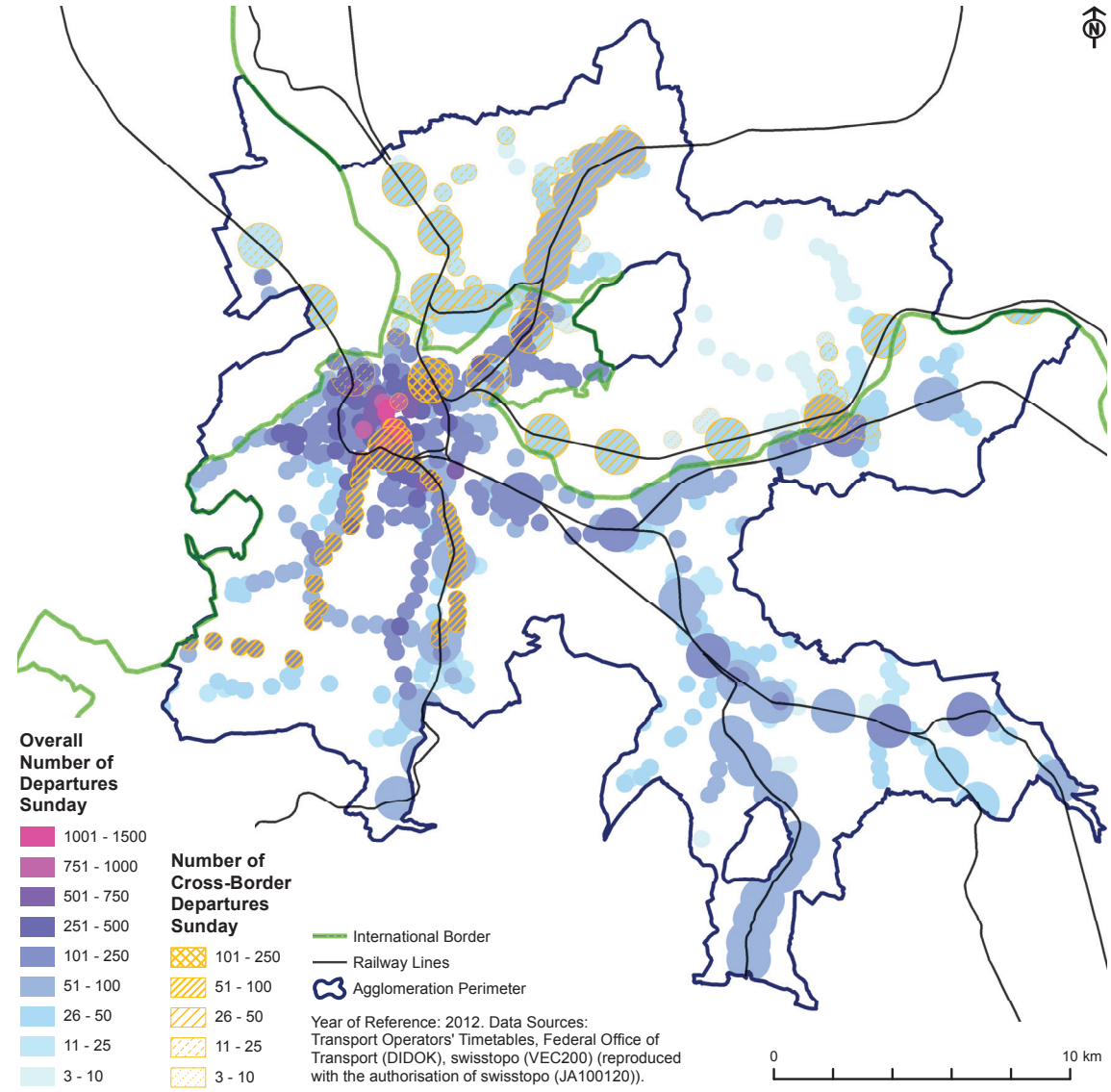
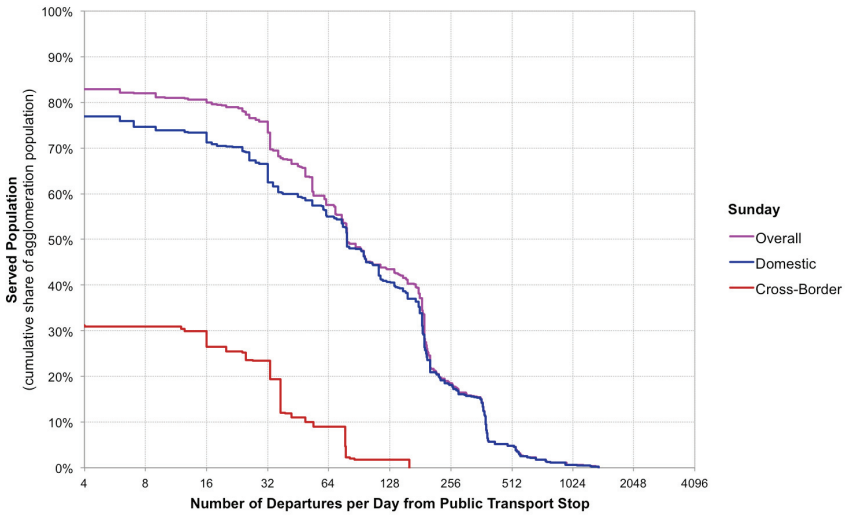


Figure 6-8: Served Population by Service Quantity, Basel Agglomeration (Sun)



Share of Population [%] within Reach of Public Transport Stops

	Cross-Border Services	Domestic Services	All Services
≥ 3 departures	31	77	83
≥ 48 departures	11	59	66
≥ 128 departures	2	41	44
≥ 256 departures	0	18	19
≥ 512 departures	0	5	5

Figure 6-9: Spatial Distribution of Service Quantity, Geneva Agglomeration (Sun)

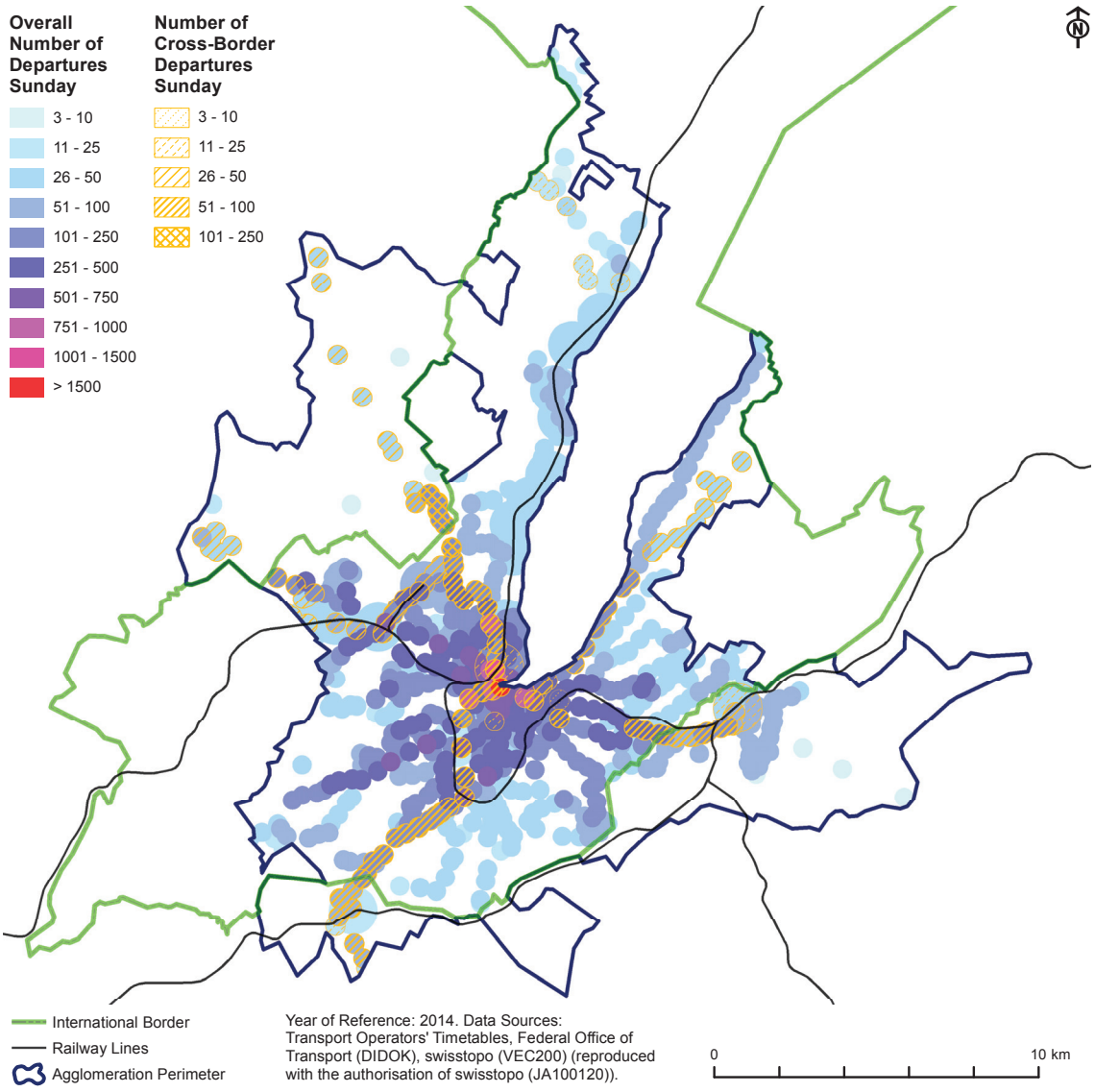
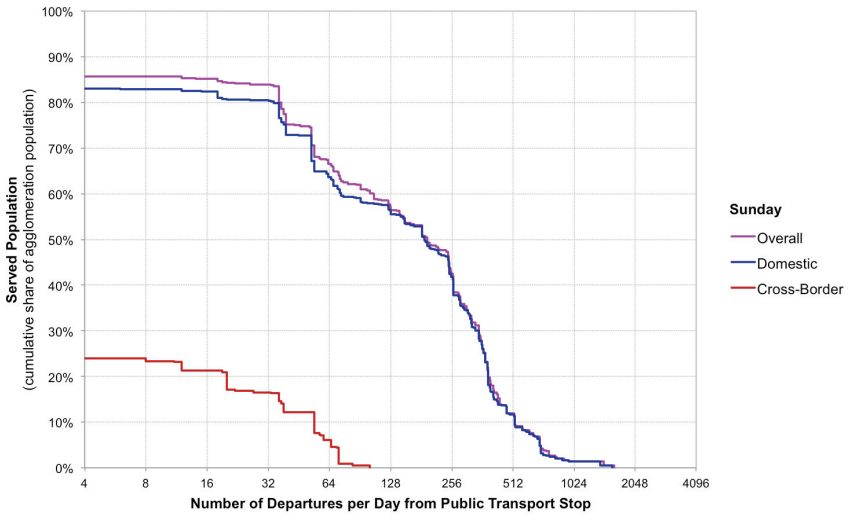


Figure 6-10: Served Population by Service Quantity, Geneva Agglomeration (Sun)



Share of Population [%] within Reach of Public Transport Stops

	Cross-Border Services	Domestic Services	All Services
≥ 3 departures	24	83	86
≥ 48 departures	12	73	75
≥ 128 departures	0	56	57
≥ 256 departures	0	42	43
≥ 512 departures	0	12	12

6.2.1.3.6 Spatial Distribution on Sundays

On Sundays (Figure 6-7 to Figure 6-10), a general service reduction can be observed both in Geneva and Basel. On the Swiss side, it is rather a minor service reduction, whereas it is much more extensive in France: In the French part of Basel agglomeration, only railways and airport buses operate, all other bus services are suspended. In the German Part of Basel agglomeration and the French part of Geneva agglomeration, many lines have no or strongly reduced service. Interestingly, many of the lines that still operate in the German and French agglomeration parts are cross-border lines, especially those with a high frequency Mondays to Fridays.

Such significant service differences between the considered countries do not occur by chance, they rather reflect the planning principles and public service standards of the respective authorities, which apparently are still clearly nationally influenced.

On those cross-border lines operating on Sundays, service quantities can be regarded as a mixture between the different standards: departures are more numerous than many domestic lines in the French and German agglomeration parts, but less numerous than most domestic lines in Switzerland.

The highest number of cross-border departures from any stop on Sundays in Geneva agglomeration is 101, and 160 in Basel. For domestic and cross-border services together, the maximum number of departures is more than 10 times higher, with 1'621 in Geneva and 1'384 in Basel.

6.2.1.3.7 Coverage of the Population on Sundays

The population share served by public transport on Sundays as compared to Mondays-Fridays has decreased from 91% to 86% in Geneva, and from 89% to 83% in Basel. For cross-border services, with a decrease from 30% to 24% in Geneva and from 38% to 31% in Basel, the reduction is proportionally higher.

Yet, an again stronger reduction from Mondays-Fridays to Sundays applies to the population share served by at least 48 cross-border departures: from 33% to 11% in Basel and from 18% to 12% in Geneva. Frequent services on Sundays are thus a rare occurrence.

6.2.1.3.8 Service duration Mondays-Thursdays

Other patterns can be observed when comparing service duration instead of number of departures. These are displayed in Figure 6-11 to Figure 6-14 for Mondays to Thursdays.

Apart from generally lower service hours in France – also a consequence of different standards of national nature –, service hours are distributed more systematically than numbers of departures, with higher values in the agglomeration centres and on main axes, and generally shorter service hours on feeder services.

Interestingly, while a difference in service duration between cross-border and domestic lines can still be observed, it is much less strong than the difference in the number of departures, especially for railway lines. Bus lines, however, still have shorter service hours, typically barely exceeding 16 hours. This can clearly be seen in Geneva, where cross-border rail services were rather rare at the time of research. Therefore, only 14 % of residents of Geneva agglomeration were served by cross-border services operating during at least 16 hours on Sundays, while this applies to as much as 85% if domestic services are also considered. For Basel with more cross-border rail services, this effect is less strong; the respective population shares amount to 31% for cross-border services and 80% for all services.

Figure 6-11: Spatial Distribution of Service Duration, Basel Agglomeration (M-Th)

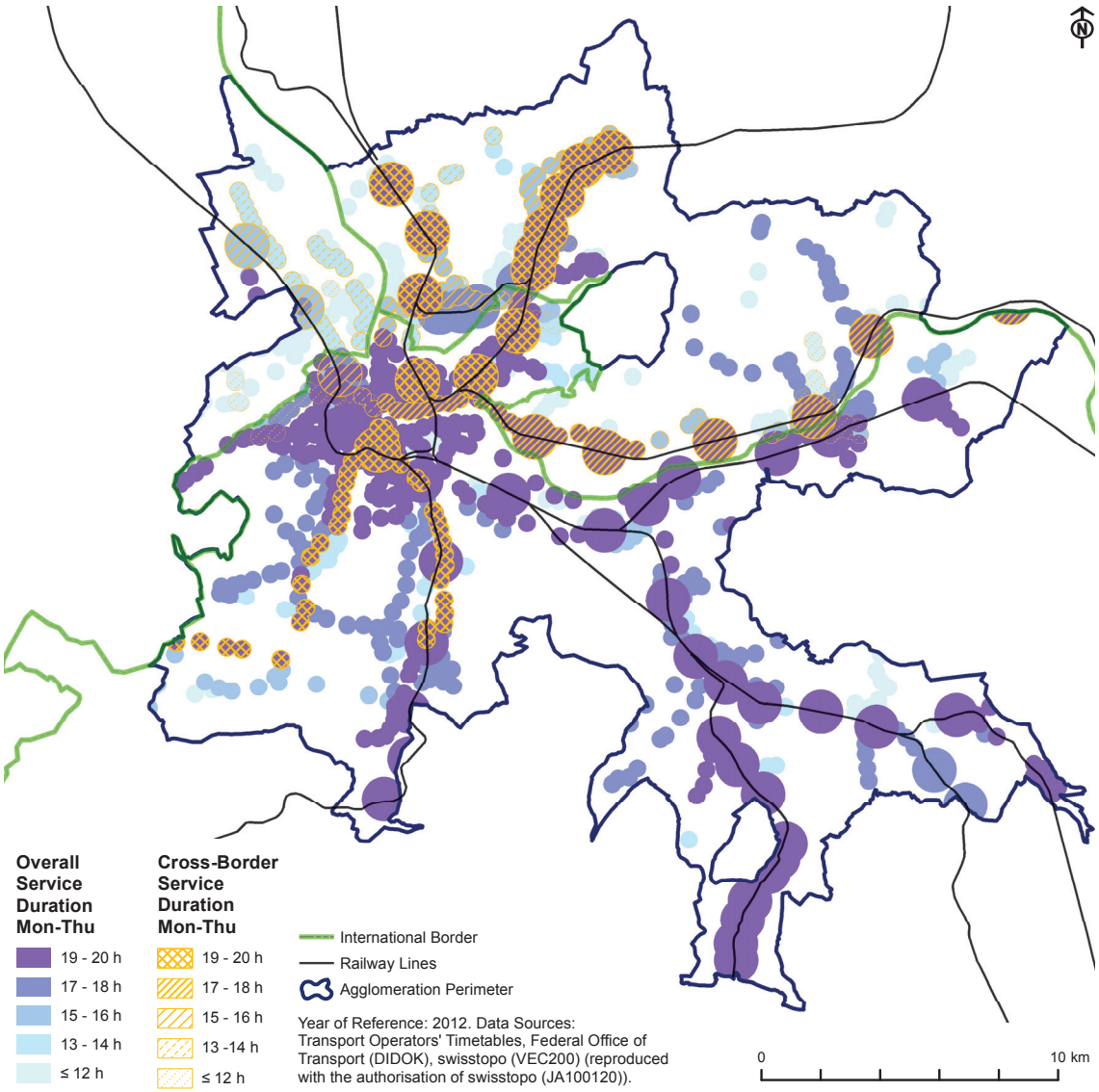
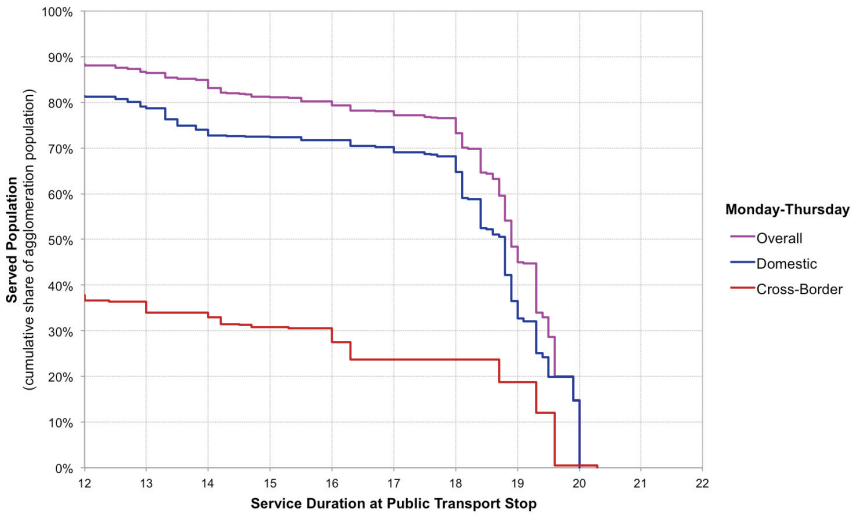


Figure 6-12: Served Population by Service Duration, Basel Agglomeration (M-Th)



Share of Population [%] within Reach of Public Transport Stops

	Cross-Border Services	Domestic Services	All Services
≥ 4 hours service	38	85	89
≥ 12 hours service	38	81	88
≥ 16 hours service	31	72	80
≥ 19 hours service	19	37	48

Figure 6-13: Spatial Distribution of Service Duration, Geneva Agglomeration (M-Th)

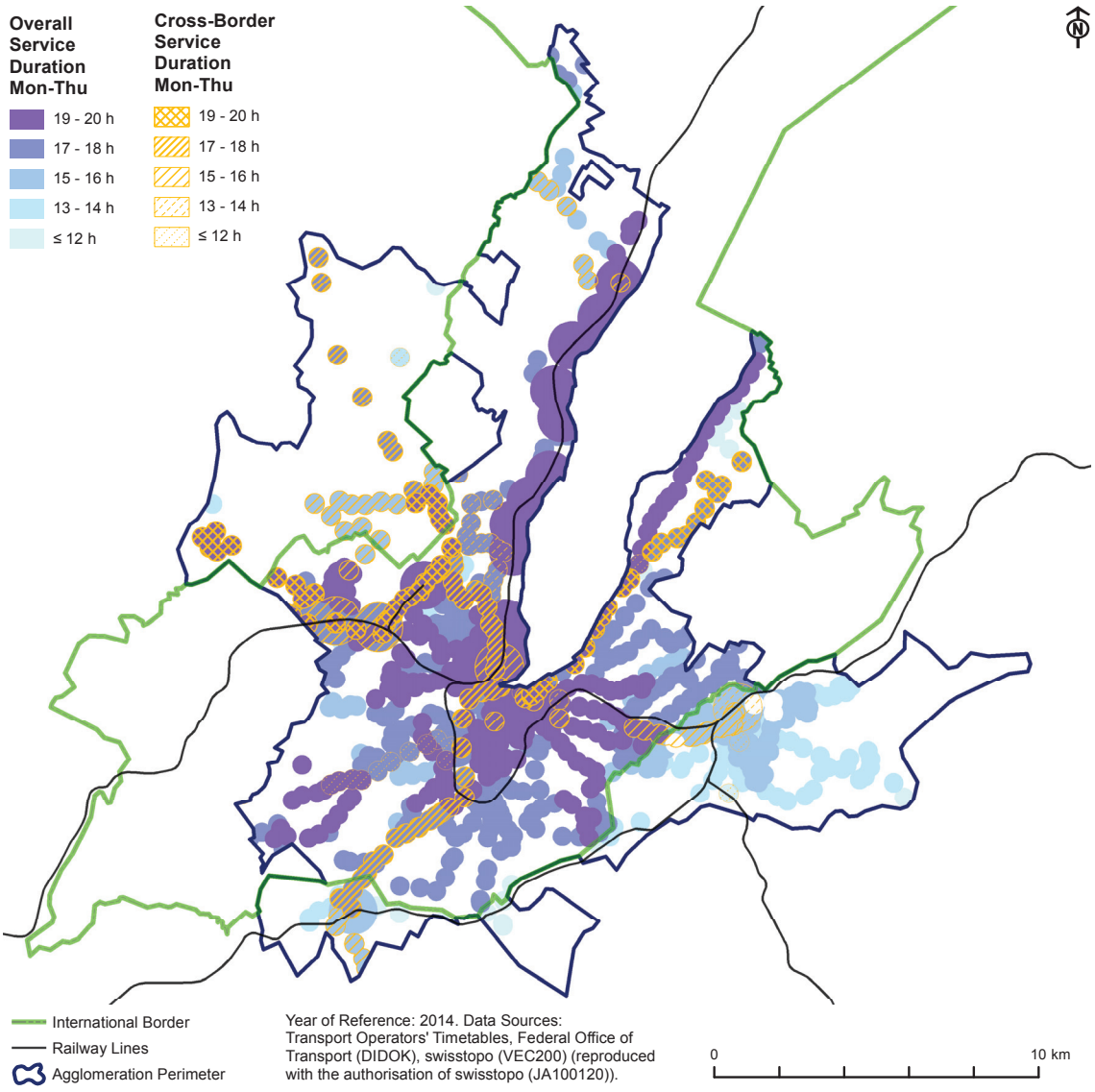
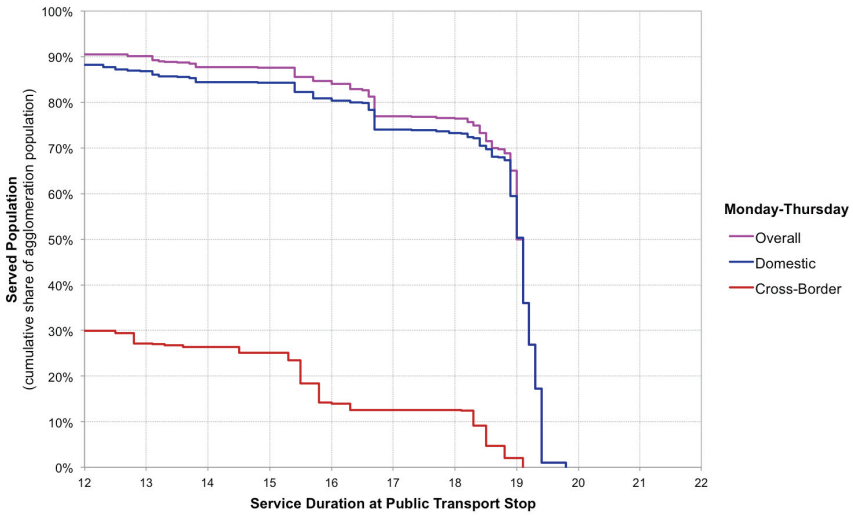


Figure 6-14: Served Population by Service Duration, Geneva Agglomeration (M-Th)



Share of Population [%] within Reach of Public Transport Stops

	Cross-Border Services	Domestic Services	All Services
≥ 4 hours service	30	88	91
≥ 12 hours service	30	88	91
≥ 16 hours service	14	81	85
≥ 19 hours service	2	60	65

6.2.2 Service Quality

6.2.2.1 Introduction

According to Table 2-9, transport speed is a service element to which public transport customers are very sensitive. The commercial speed, as an attribute of public transport lines, is objectively measurable and has been used here as an indicator to compare service quality of bus and tramway lines. Research interest R 4 suggests that domestic and cross-border services may have different transport speeds.

The commercial speed of a line, i.e. the average speed between the departure at the first stop and the arrival at the last stop (excluding layover times at terminus stops and waiting times of more than 5 minutes at interchange stations) is the relevant indicator for customers. It depends on three main factors: distance between stops, dwelling time of vehicles at stops and en-route duration between stops. The latter is again influenced by vehicle properties and infrastructure conditions (right of way, speed maximum etc.).

6.2.2.2 Commercial Transport Speed

To test the influence of the border crossings and other variables on commercial speed, a multiple univariate regression has been carried out. Data were collected for all tram and bus lines within the agglomeration perimeters of Geneva and Basel, with the exception of lines that only marginally extend into the perimeter area.

The first predictor variable is given by the existence of a border crossing within the agglomeration area; the other influences were represented by mode (bus / tramway) and the passenger potential (number of inhabitants within catchment areas) per kilometre line length. The latter variable represents both the population density in the area of the line, as well as the distance between public transport stops.

As shown in Table 6-2, these variables together can fairly well predict the commercial transport speed with a linear regression model ($R^2 = 0.514$). Figure 5-6 with a logarithmic x-axis suggests that a logarithmical model might produce even better results. Of interest here, however, is whether lines crossing a border have generally lower commercial speeds. The beta values and levels of significance of Table 6-2 clearly show that this is not the case: The predictor variables border crossing and mode barely contribute to the estimation of the response variable ‘commercial speed’ and show high probabilities of error.

The same effect can also be observed in Figure 6-15, where all points (bus, tramway, domestic and cross-border lines) follow the same pattern.

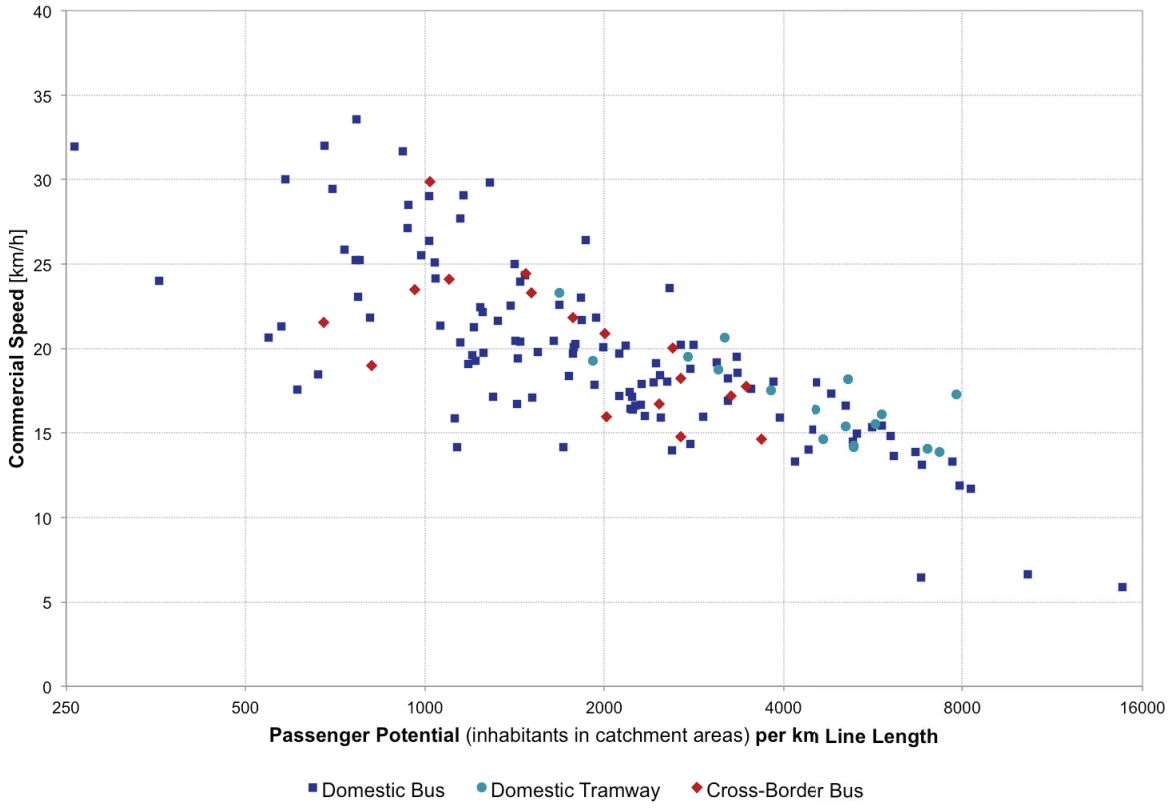
Table 6-2: Linear Regression on Commercial Speed

Response Variable: Commercial Speed of Public Transport Line $R^2 = 0.514$		
Predictor Variables	Beta	Sig.
Existence of Border Crossing (No / Yes)	-0.026	0.662
Mode (Bus / Tramway)	0.054	0.389
Passenger Potential per km Line Length	-0.735	0.000

It is interesting to note that tramway lines generally have a higher passenger potential per km, while cross-border bus lines do not exceed the passenger potential value of 4'000 per kilometre. Thus, tramways occur more often in densely populated areas and with shorter distances between stops, while cross-border bus lines follow the opposite trend. Domestic bus lines, however, can be found across the entire range.

From this, it follows that cross-border bus lines are not systematically slower, nor faster, than domestic bus or tramway services.

Figure 6-15: Commercial Speed of Local Public Transport Lines (Geneva and Basel)



The exact values in Figure 6-15 (incl. line designations) are shown in Table A 9, p. 188.

6.3 Fares

6.3.1 Fare Areas

6.3.1.1 Introduction to Fare Areas

Most European cities and agglomerations have established integrated fare areas. Fares in these areas follow a one-ticket-policy that enables a single ticket to be valid for any public transport journey within the area, even if the journey involves different means of transport or different transport operators. The fare calculation is based only on the number of zones travelled through. Exceptions may apply for short journeys (typically, a special fare for max. 3 to 5 stops is offered) as well as for trips extending beyond the fare area limits.

Fare areas can be established by transport operators, by transport authorities, or jointly by parties of both sides. According to the setup of these institutions, they can adopt various tasks including marketing and planning, but in any case, they define the modalities on how ticket revenues are shared among the transport operators (and, possibly, transport authorities) (Knieps 2004).

6.3.1.2 Geneva

In Geneva, the fare area ‘unireso’ covers both Swiss and French parts of the agglomeration. ‘Unireso’ distributes all fare types (single, day and season tickets as well as a variety of tickets combined with other offers) as well as fares of all transport operators (buses, tramways, trains and boats). The only exception are the French Railways SNCF, offering their line-based fares in parallel to ‘unireso’ fares. Within ‘unireso’, the complexity of fares has been considerably reduced, as there remain essentially only three fare levels:

(i) Journeys within the entire canton of Geneva, represented by zone number 10
(ii) Journeys crossing cantonal or national borders (by adding cross-border zones) and
(iii)Short cross-border journeys on designated sections (not zone-based).

Fares are offered both in euros (EUR) and Swiss francs (CHF) at the same price level. Therefore, euro prices of cross-border tickets are subject to being updated regularly.

While the governance of fares is actually in the responsibility of the canton of Geneva (for Swiss domestic tickets) and of the ‘GLCT’ (Groupement Local de Cooperation Transfrontalière) cross-border institution, this duty has been assigned to unireso by means of agreements over several years. ‘Unireso’ basically does not cover domestic tickets in France, but the responsible authorities have voluntarily agreed on a common unitary tariff for journeys within French zones, which is now also available through ‘unireso’ distribution channels.

The functioning of ‘unireso’ can be seen as an exemplary case, since it has simplified a potentially very complex issue to a fare system that is relatively easy to understand and use.

6.3.1.3 Basel

In Basel, however, the situation is a little more complicated: Both 'Tarifverbund Nordwestschweiz' (TNW) and 'Regio-Verkehrsverbund Lörrach' (RVL) are operator-based integrated fare areas, covering the Swiss and German parts of the agglomeration respectively. In the French part, the French 'communauté de communes des trois frontières' (CC3F) authority governs bus tariffs of the so-called 'distribus' network. Yet again on the French railway line, the fares of SNCF, the French railway operator, apply.

TNW and RVL, each for itself, function similarly to 'unireso' in Geneva, and the internal tariffs of CC3F and SNCF are not difficult to understand. While these fare systems are well established within the different parts of the agglomeration (i.e. for domestic tickets), travelling between them (i.e. across borders) is more difficult. Fares for such journeys are mostly based on various bilateral agreements between the respectively involved institutions. The shortcomings from a customer perspective include the following points (as of May 2014 (RappTrans 2009; Stucki 2010; Tarifverbund Nordwestschweiz and Regio Verkehrsverbund Lörrach GmbH 2012; unireso 2014)):

Single Tickets:

- In spite of the great variety of tickets offered for cross-border journeys, the one-ticket policy is not available on some cross-border relations, especially for journeys with start or destination outside of the agglomeration centre (zone 10 = Basel and surrounding Swiss communes.).
- The conditions to be eligible for reduced fares is different in each fare area (that generally follow national standards) and no common regulation for cross-border tickets could be determined so far.
- Return journeys require two single tickets. Tickets for the outward and return journey have to be bought in different currencies (EUR/CHF), may have a different price, and follow different rules for fare reductions.
- While holders of the popular 'Halbtax-Abonnement' card of Swiss Railways are granted fare reductions within TNW, these reductions are not applicable to cross-border tickets. As a result, with a 'Halbtax-Abonnement', the lowest cross-border fare from Switzerland to Germany costs 83% more than a domestic ticket within the Swiss agglomeration centre (TNW zone 10).
- A fare for short cross-border journeys does not exist between Switzerland and Germany, rendering this type of trips very unattractive in terms of price. Also, the significance of the border is clearly strengthened by this aspect.
- As fare levels are much lower in France than in Switzerland, a clear discontinuity in the price / distance ratio applies at this border: A domestic bus ticket within the French agglomeration part is available for EUR 1.30, including the use of cross-border bus lines penetrating radially into the Swiss agglomeration centre. Yet, if connecting services within the Swiss agglomeration centre are to be used (zone 10), the fare jumps up to EUR 3.00 (+131%). Moreover, the 'French' EUR 1.30 fare is available from bus

drivers only, while ticket machines at public transport stops in Switzerland only sell the EUR 3.00 (CHF 4.20) fare.
- Single tickets for the French railway line are always limited to railway lines; tickets including connecting bus or tramway services in the agglomeration of Basel do not exist.

Season Tickets:

- Cross-border season tickets are available as a combination of existing season tickets of two institutions (TNW in combination with SNCF, CC3F or RVL). Since the TNW offers season tickets only as a flat fare for its entire area embracing as much as 1'101 km^2, the minimum validity area for cross-border season tickets is even higher. Therefore, cross-border season tickets often cover large areas which customers do not need. This applies especially to cross-border commuters with start / destination in the Swiss agglomeration centre close to the border, a customer group being of considerable quantitative importance.
- The only exceptions are the French and German bus and railway lines penetrating into central Basel, for which cross-border season tickets can also be issued based on (cheaper) domestic tariffs. This, however, excludes the use of connecting services in Switzerland.

Day pass:

- The day pass 'TicketTriRegio' is the sole fare item which is valid in all fare areas of the trinational agglomeration (TNW, RVL, CC3F and SNCF), including all transport operators. It can be purchased for the same price (in Swiss francs or euros) through all distribution channels.
- The 'TicketTriRegio mini' covers only a smaller trinational perimeter and is available at a lower price. Therefore, it is also frequently used for return journeys, in order to avoid the difficulties with cross-border single tickets, even if the latter would be less expensive.

However, the need for a harmonisation of the transboundary fare offer in Basel has been recognised. As a first step, a common website bringing together most fare and timetable details has been realised recently (RVL & TNW, 2012). In the longer term, a study commissioned by RVL and TNW recommends to merge the different fare areas, at least to such an extent that they appear to customers as an unitary organisation (Rapp Trans, 2009).

6.3.1.4 Other Agglomerations

The two above-considered cases can be regarded as exemplary cases of integrated (Geneva) and semi-integrated (Basel) cross-border fare systems. Other cross-border agglomerations considered in this study (for Aachen and Maastricht, cf. Juchelka (2004)) also show characteristics of semi-integrated fare systems across borders. The following phenomena can be observed most frequently:

- Non-availability of tickets for certain cross-border relations (need for separate consecutive tickets), especially for single and season tickets; cross-border regional day passes have become more widespread.
- Non-applicability of fare reductions (in contrast to domestic services)
- Fare level discontinuities triggered by different purchasing powers for local public transport services.
- High complexity of fare range
- Limited distribution channels for cross-border tickets

7 Synthesis of Results

7.1 Characteristics of Cross-Border and Domestic Local Public Transport

7.1.1 Framework Conditions

7.1.1.1 Research interest R 1

7.1.1.1.1 Research interest

Are international borders in cross-border agglomerations affected by distinct differences in land use and transport facilities?

Indicators:

- Settlement density
- Spatial coverage of the population by public transport networks

7.1.1.1.2 Findings

The spatial analyses have shown that the differences in land use and transport facilities caused by the existence of international borders, which have been questioned initially in chapter 2.5.1.2 exist as follows:

In terms of settlement density, borders were found to represent clear discontinuities in many cases. Interestingly, this sudden effect occurs both for increases and decreases of the population density. Thereby, the population distribution does not follow the standard case where population density decreases with distance from the agglomeration centre (with the exception of sub-centres only). The observed border effect in terms of population density results in more irregular and less uniform urban settlement structures.

This has to be considered in view of the fact that for public transport, providing efficient and effective services on a local level is easiest in uniform settlement structures, where the demand potential is distributed in more regular structures.

The absence of ring lines across borders, and the rare occurrence of cross-border lines with diametric or tangential route courses may also be considered in this context: Achieving satisfactory capacity utilisation levels is certainly more difficult in these uneven settlement structures and contributes to the inferior network quality.

Regarding the spatial coverage of the population by the network of local public transport service, the analysis revealed very clear differences could be found: While around 90% of the

population of Basel and Geneva agglomerations reside within the catchment area of public transport stops, the share of inhabitants served by cross-border services amounts only to 30% and 38% respectively.

Moreover, extensive agglomeration areas, especially within the country of the agglomeration centre itself, are not served by any cross-border services (neither rail nor bus). Many cross-border relations thus require one or several interchanges, thereby considerably impairing their attractiveness. The fact that many cross-border lines are of radial nature, and thus terminate in the agglomeration centre, additionally contributes to the low number of direct connections.

The cross-border infrastructures, as a precondition for the provision of public transport services, are also influenced by the existence of borders. For railways, the availability and quantity of border crossings is mostly influenced by the historical development and strategic importance of cross-border connections. For roads, however, this is dependent on possible spatial coincidences with physical obstacles (e.g. rivers) that significantly lower the density of available border-crossing infrastructures. Generally, cross-border infrastructures are less numerous and / or less developed than in a domestic context.

The framework conditions of the built environment can thus be considered to differ between a cross-border and a domestic context, as it has been suggested in research interest R 1.

Further issues on framework conditions that are not part of the present research interest include the legal and regulatory bases, the quality of cross-border (‘international’) relations as a result of the historic development, as well as possible economic, political and linguistic differences between countries.

7.1.2 Demand

7.1.2.1 Research interest R 2

7.1.2.1.1 Research interest

Do demand structures for local cross-border relations differ from domestic ones?

Indicators:

- Overall modal split
- Share of captive riders in public transport
- Mix of trip purposes

7.1.2.1.2 Findings

This research interest has mainly been treated on the basis of the case studies of Geneva and Basel. The statistical bases that have been consulted reveal in the first instance that the daily demand of local and regional cross-border traffic consists of very important volumes: Around 100'000 people per working day in Basel, and almost twice as much in Geneva.

The calculation of border resistance (or induction) values, which would, as suggested by previous studies, represent the traffic reduction across border as opposed to domestic areas, did not prove to be of use here. They can only be derived by means of separate calibrations at each border crossing and would not be spatially nor temporally transferable or generalisable.

However, the qualitative properties of cross-border public transport demand, which have initially been identified as a gap in research (cf. 2.5.2.2), could be analysed in more detail, both by means of empirical data and by consulting selected existing datasets.

It could be observed that modal shares of public transport are much lower across borders than for domestic traffic. These low modal shares may be the result of various factors: They may be a caused by a lower quality of the public transport service offer (see research interest R 4). They could also come from less attractive fares (see research interest R 5). Yet, they could also arise from different attitudes, needs and expectations of passengers and potential passengers (see research interest R 3).

The empirical studies also revealed – as opposed to what may be expected – that there are less captive riders on cross-border lines of local public transport than on domestic ones. Instead, a majority of cross-border passengers are choice riders who have another mode of travel at their disposal.

Also, the mix of trip purposes differs significantly from the domestic situation: Work commuters constitute the vast majority of demand. This demand sector appears to be intensified by the existence of borders (and their associated side effects, such as differences in wage levels), as its dominance is much greater than in domestic public transport. The temporal coincidence and the unidirectional nature of work commuters result in strongly accentuated demand peaks that lead to a heavy utilisation of transport infrastructures and services during few hours, and relatively low traffic volumes throughout the rest of the day.

7.1.2.2 Research interest R 3

7.1.2.2.1 Research interest

Are the expectations and needs of passengers the same for domestic and cross-border journeys?

Indicators:

- Passenger satisfaction
- Motivation of passengers to use public transport

7.1.2.2.2 Findings

The effect of borders on individuals represents one aspect of the questioned effects of borders on demand. The examination of results from empirical passenger surveys in combination with objectively measured data of service quality (both from the case study agglomerations of Geneva in Basel), lead to the conclusion that the expectations of both for cross-border and domestic passengers to the quality of service are very similar, if not identical.

While passenger satisfaction levels do vary between different lines of public transport, these variations could be explained by measurable differences in quality. Where equal quality standards were provided, all passenger groups (i.e. cross-border and domestic passengers on either side of borders) usually made similar ratings for the respective quality element (e.g. comfort).

The facts that some cross-border lines obtained lower satisfaction ratings, that passengers made very rational and reasonable ratings, and that at the same time cross-border modal shares are quite low, all support the conclusion that an accordingly improved service quality on these cross-border lines could also attract additional customers.

However, in contrast to these balanced expectations of customers, important differences could be found in the motivation of passengers to use public transport, and the respective needs towards public transport:

In the agglomerations of Geneva and Basel, the empirical passenger surveys revealed that the work / professional trip purpose clearly dominates on cross-border lines. Yet, another image results if passengers are considered separately according to their country of residence:

Public transport users residing in France or Germany do not only represent the vast majority of cross-border passengers, but they show an even stronger dominance of the work / professional trip purpose. This is also reflected in the asymmetric temporal distribution of demand with very high demand peaks towards Switzerland in the morning, and in the opposite direction in the evening. Interestingly, the majority of these passengers are choice riders, i.e. having an alternative transport option at their disposal, but deliberately choosing public transport for these trips.

On the contrary, Swiss residents using local public transport across borders do so primarily for shopping and leisure purposes, and only rarely for work / professional purposes. Also, a

considerable share of Swiss cross-border passengers consists of captive riders who live in households without car availability.

These two strongly contrasting user groups of cross-border lines in the agglomerations of Basel and Geneva may have different needs towards public transport. However, as the demand flows apply in opposite directions, and since their temporal coincidence is marginal, they can very well be served by the same transport system. Indeed, the use of cross-border public transport by both user groups would increase the efficiency of public transport infrastructure and vehicle / rolling stock usage.

7.1.3 Service Offer

7.1.3.1 Research interest R 4

7.1.3.1.1 Research interest

Do the characteristics of service elements vary between domestic and cross-border local public transport?

Indicators:
- Speed
- Frequency
- Service Hours

7.1.3.1.2 Findings

The existence of an objectively measurable difference in service quality between domestic and cross-border routes (as opposed to subjective impressions) has been identified as one of the major research gaps for this theme (cf. 2.5.3.2). The analyses of this study have revealed that not all public transport service characteristics are equally affected by borders:

The commercial speed, one of the most significant indicators for service quality, has shown not to be directly dependent on border crossings. Instead – as the conducted regression analysis for bus and tramway lines clearly showed – the commercial speed is strongly related to the factor ‘passenger potential per km line length’, which represents both the (population) density of the concerned area and the distance between stops. This applies equally to domestic and cross-border lines.

Yet, it could even be argued that cross-border bus lines tend to have higher commercial speeds, since in the analysed agglomerations, the passenger potential of cross-border bus lines never exceeds 40'000 people in total, or 4'000 people per kilometre. Yet, an increase of the passenger potential of cross-border lines could be desirable as it would raise the share of inhabitants served by cross-border public transport services. The mechanisms influencing transport speed are however the same for both domestic and cross-border lines.

As opposed to buses, quantitative analyses of the transport speed of rail services have not been carried out, since it had been assumed that the attainable railway speed levels are mainly dependent on the state of rail infrastructures, of deployed rolling stock and of the adopted

timetable policies (primarily: served stations). In the course of the project, no border-related influences that would have an impact on railway transport speed and the mentioned factors could be observed.

The analyses regarding service quantity (i.e. frequency and service hours), which have been carried out for bus, tramways and railways, revealed a clear distinction between domestic and cross-border services:

The number of departures of cross-border services is significantly lower than of domestic services:

- If analysed on a per-line basis, the average number of departures (Mondays-Fridays) is roughly half as high on cross-border lines, as compared to domestic lines. This applies in spite of the fact that on many lines, the number of departures has already increased in the period from 1994 to 2014, and only a few new lines have been established during these years.
- If departures are counted on a per-stop basis, the differences are even stronger: Important local public transport stops can have well over 1'000 departures per day; whereas the maximum observed number of cross-border departures from any stop amounts to approximately 280 departures (Mondays-Fridays). Most stops with cross-border services are served by less than 100 cross-border departures per day (total of all directions).
- If the amount of departures is investigated according to the number of inhabitants that live within catchment areas of concerned public transport stops: Only 4% (Basel agglomeration) to 5% (Geneva agglomeration) of the population lives within the catchment area of a stop with 128 or more cross-border departures per day (as opposed to 51% and 66% respectively for domestic departures).

The number of departures on a certain route is, however, not only dependent on its border crossing, but also on the planning principles and public service standards of the responsible (contracting) transport authorities: Service quantities of domestic services vary strongly within the considered agglomerations, as it can be seen most clearly on the basis of the indicators ‘number of departures on Sundays’, or of the ‘service duration Mondays-Thursdays’: In France, and to a certain extent also in Germany, the suspension or extensive reduction of services on public transport lines of mediocre or minor importance on weekends and evenings is widely common; in Switzerland, however, this practice is not applied. In case of such disparities, cross-border lines usually adopt a compromise between the levels of the involved authorities’ service levels; in doubt, they follow the lower level.

7.1.3.2 Research interest R 5

7.1.3.2.1 Research interest

Are cross-border journeys affected by more complex fare systems and less attractive price levels that may be caused by incompatibilities of different domestic fare systems?

7.1.3.2.2 Findings

Establishing an attractive and easy-to-use fare system within international cross-border agglomerations has been found to be a major difficulty. To do so, stakeholders have to find special and dedicated solutions on their own; they cannot start from a commonly available system. In particular, solutions have to be found to integrate the following points within one system:

- The purchasing power within different areas of the agglomeration
- Different currencies
- Rules for reduced ticket fares (children, concessionary fares, subsidised tickets etc.)
- Fare determination methods (e.g. size of zones, non-zone-based fares)
- Distribution channels, ticket formats and ticket validation (e.g. punching) modalities

The considered agglomerations have solved these challenges in different ways. In many cases, fare agreements are based on bi-lateral agreements. However, the most attractive fares, in terms of ease-of-use, can result from multi-lateral agreements that cover the entire agglomeration and all means of public transport. Such multi-lateral agreements, however, require a great deal of coordination and cooperation among stakeholders.

Different agglomerations have managed to introduce agglomeration-wide (multilaterally organised) day passes. However, the integration of all fares, including single and season tickets has so far only been achieved in the case of Geneva, where the agglomeration-wide, cross-border fare area ‘unireso’ could be established. This was only possible thanks to an institutionalised, multi-lateral cross-border cooperation framework, the *‘GLCT des transports publics’* (cf. 6.1.1.4, p.115).

7.2 Fields of Action and Approaches

7.2.1 Introduction

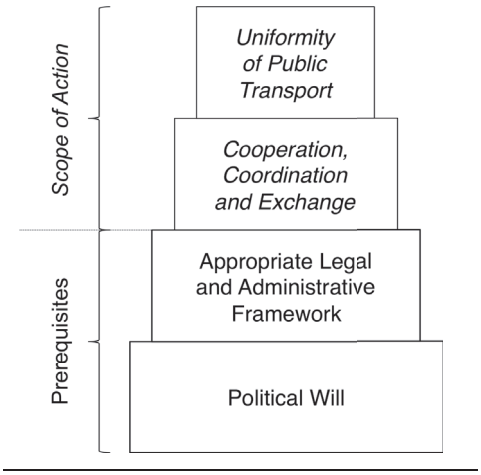
This chapter aims at using the gained knowledge to derive approaches and fields of action for tackling the identified shortcomings of public transport systems in cross-border areas.

The chapter is also intended to deal with the research interest R 6: Although the characteristics of cross-border agglomerations may vary from one case to another, is it possible to distil a common set of basic strategic principles to tackle the challenges of providing local public transport across borders?

It is structured in 4 main points (cf. Figure 7-1):

It starts with two preconditions, without which improvements are hardly achievable: Political will (7.2.2) and the legal and administrative framework (7.2.3). Subsequently, two approaches that open the scope of improvement for any affected agglomerations are presented: Cooperation (7.2.4) and the uniformity of public transport (7.2.5)

Figure 7-1: Proposed Steps in Reducing Border-Induced Effects on Local Public Transport



7.2.2 Political Will

The political will of local and regional governments to maintain a good system of local public transport is a first and foremost prerequisite to approach the field. It is not only the public transport system within the respective limits of responsibility that has to be supported, but also the lines and relations that go beyond and connect to neighbouring areas.

In spite of the fact that several contiguous political entities may form a common conurbation with strong functional interrelations, their goals in term of transportation can still diverge, and the will to cooperate in these questions may lack. As noted by Rieder (2014), this may be a result of fiscal policies or other strategies that have been adopted in one area and have negative repercussions to other areas.

The awareness of, and a certain extent of understanding for, the situation and the needs of partners across borders are of considerable importance. This does not require unanimity, but prevents from unnecessary prejudices and misunderstandings. While formal contacts can be helpful in this regard, it would be even more advantageous if also informal connections and networks of responsible persons across borders could contribute to this awareness.

7.2.3 Legal and Administrative Framework

7.2.3.1 Local / Regional and National / Supra-National Levels

In terms of the legal and administrative framework, this study distinguishes between the local / regional competence level and the superior (supra-)national level. The (supra-)national level should provide a basis for local and regional problems to be solved at the appropriate lower level, even if this involves cross-border areas.

7.2.3.2 Cross-Acceptance at a Local / Regional Level

In technical regards of public transportation, it is vital to address the interoperability of vehicles across borders. While on the European level, considerable efforts are made to improve the interoperability of railways (cf. 2.3.7.1), the operation of cross-border services – as compared to domestic services – will also in future undoubtedly remain more costly and complicated.

An effective approach would therefore consist in tolerating standards and licences of neighbouring countries for the operation of local and regional public transport services within own borderlands, as long as technically possible, and as far as substantial safety issues are not concerned. This could apply, for example, to a local / regional cross-acceptance of personnel and vehicles, or to regulations concerning the accessibility for people with reduced mobility (that are more difficult to comply with in case of varying infrastructure standards, e.g. platform height). Additionally, in order to prevent national regulations from being circumvented unnecessarily, a clear definition of the scope in which these tolerances for cross-border services are accepted, would need to be elaborated.

Further aspects that can be dealt with on this superordinate level include the regulations on performing cross-border services that include accounting (tax) regulations, access to markets (cabotage) and labour law. Again, solutions could be sought to be applied on local / regional levels and in borderlands only, instead of nation-wide changes.

7.2.3.3 Governance Competences at a Local / Regional Level

When regarding legal and regulatory aspects, the competence of local and regional governments and authorities to have their ‘foreign policies’ and to cooperate with neighbouring partners beyond borders is most important. Furthermore, cross-border legal entities (as described in 6.1.1.4.1) allow the devolvement of certain operational competences – such as e.g. medical, logistics or public transport services – to an agglomeration-wide institution that may be able to perform these services more efficiently. The legal bases that allow the authorities and governments to carry out these cross-border activities or, at least, to tolerate them, are a precondition. This possibility is not given in those cases where cross-border cooperation is based on ‘ad hoc’ structures or networks that are not established by national and supra-national law (cf. 6.1.1.2 and 6.1.1.3).

7.2.4 Cooperation, Coordination and Exchange among Local / Regional Governments and Authorities

Given the political will and the possibilities of the legal and regulatory framework as described in the previous sections 7.2.2 and 7.2.3, it is in the hands of local and regional governments and authorities to make appropriate use of the available instruments.

On the one hand, formal and informal personal contacts and networks have to be applied to establish a trust-building basis and to understand each other's situations, problems and motivations. Such structures can also be used to initiate projects at short term, to explore options or ideas on a non-binding basis, or to initiate agreements on issues of limited complexity.

On the other hand, for the joint tackling of problems or the mutual provision of services, it may be beneficial to transfer these tasks to a dedicated legal entity. The supranational framework for the creation of such cross-border institutions has in recent years been established for most European borders (cf. 6.1.1.4.1), but many potential application areas have been reluctant so far to establish such cross-border structures. Where they do exist, they are often commissioned with strategic tasks, such as long-term visions or the general strengthening of cross-border relations, or with the support of local authorities for particular cross-border projects.

The assignment of operational tasks from local or regional governments in terms of public transport could so far only be observed in the case of Geneva, where the *'Groupement Local de Coopération Transfrontalière (GLCT) des Transports Publics'*, together with the coupled *'comité stratégique'*, is responsible for all cross-border bus services in the agglomeration, both in strategic and operational regards (cf. 6.1.1.4.2). Amongst others, it ensures a consistent service offer across borders, governs cross-border fares and determines the distribution of costs to the different authorities according to a harmonised calculation modality. Thereby, the various bi-lateral coordination efforts between the different authorities of the agglomeration could be diminished, while at the same time, the service offer could be made more attractive.

The functioning of this GLCT is very promising, and suggests that such structures should also be applied in other areas. For the establishment of such cross-border structures, where competences are taken away from authorities and transferred to such institutions, requires among members a high level of trust as well as a certain extent of similarity of goals and visions in terms of public transport operations and development. Additionally, the presence of one or several persons, who personally support and promote this novel form of cross-border cooperation, might prove decisive for its implementation.

7.2.5 Uniformity of Public Transport and Its Limits

7.2.5.1 Scope of Action

As it has been found in this study, cross-border agglomerations and their transport systems are not uniform but rather differentiated in many ways. Fares, timetable structures, information channels, design as well as responsible authorities and operators are subject to variations throughout agglomerations, especially at borders.

In this regard, the paramount goal for local public transport is essentially the removal of negative impacts of borders on service elements, and the creation of an agglomeration-wide, uniform system.

It is, however, illusory that all differences could be removed and cross-border agglomerations might once function entirely in the same way as domestic conurbations. Also, some of the existing disparities between cross-border and domestic services, and between the service levels in the different agglomeration parts may have a good reason and might well be justifiable to a certain extent.

Yet, there are some key areas of improvement that allow both a coexistence of a certain level of (necessary) variation, but at the same time also considerable agglomeration-wide improvements of the public transport system and its attractiveness. These have been derived from the findings of this study and are presented in the following sections.

7.2.5.2 Information and Marketing

While organisational structures may be of intricate nature, this complexity does not have to be passed on to customers and potential customers. An information platform that contains agglomeration-wide information, as well as common appearance principles, can significantly enhance the ease of use of public transport within a cross-border agglomeration. Many cross-border agglomerations currently show clear deficits in this regard.

A common information platform should in any case consist in a website, brochures, telephone enquiries and information booths that offer *all* relevant information of public transport (timetable search engine, line- and stop-based tabular timetables, short-term timetable alterations, complete range of fares including terms & conditions, maps, news, ticket sales locations, contacts etc.).

Since most of this information originates from transport operators, and as they may be interested in presenting these (valuable) contents through their own appearance channels, rather than on a common platform, the allocation of public service contracts to transport operators could be made conditional on the delivery of accurate and up-to-date information to the general information platform. From there, the contents could again be forwarded to other, national or regional information platforms.

Apart from the fact that information is provided, the way the in which it is communicated is also of importance. In the case of cross-border agglomerations, attention should be paid especially to use identical designations for lines and stops throughout the agglomeration

(although this seems obvious, numerous deviations from this principle can still be observed). Moreover, common design principles, such as the arrangement of timetables, signs at public transport stops etc. can make the use of public transport more straightforward and thus increase its attractiveness especially for occasional users. Of course, all information should be available in any language spoken within the agglomeration.

7.2.5.3 Fares

In the field of fares, some difficulties are naturally linked to cross-border agglomerations and may never be entirely overcome. These include the differences in purchasing power, different nationally oriented regulations and standards regarding fare discounts as well as the possible coexistence of different currencies.

It is therefore even more important that those shortcomings which can potentially be removed or diminished are actually tackled. This notably involves the three following points:

- The same range of fares should be available through all distribution channels, and it should be sold at identical prices throughout the agglomeration (in particular, equivalent prices for either direction of travel).
- No 'penalty' fare should be charged for cross-border trips: Cross-border trips should not cost more than domestic trips of similar distance. This applies equally to short trips (i.e. few stops only) as well as to longer distances within agglomeration limits. Furthermore, if a passenger is eligible for reduced fares in one country only, it should be possible to take this discount into consideration to the proportional extent of the respective area of applicability.
- Fares should be available to travel from any point to any other point within the agglomeration limits. Thereby, the need to buy separate tickets for one single journey would become obsolete.

The adoption of these three points still leaves the possibility, if necessary, to use different price levels for different agglomeration parts, to have different zone sizes, or even to combine zone-based and line-based tariffs. They may also be a first step towards a fully integrated cross-border fare area.

7.2.5.4 Service Coordination

Also in regard of the service offer, entirely uniform service levels throughout the agglomeration would be desirable, but are barely realistic at short or medium term, given the different backgrounds of the agglomeration parts. There are, however, goals that can be realistically achieved and that would already result in a considerable improvement for the entire public transport system.

This particularly entails improving the network structures: While today, cross-border lines often serve at connecting suburbs to the agglomeration centre, they could be integrated much better into the agglomeration's public transport network: By connecting two existing lines to diameter lines that cross the agglomeration centre, more direct connections can be created,

and ridership may be increased by simultaneously serving transport needs within the agglomeration centre and between the agglomeration centre and suburbs.

Such network adjustments and improvements are in principle to be initiated by transport authorities, or by cross-border institutions acting on their behalf (cf. 6.1.1.4). It may, however, also be beneficial for transport operators to seek cooperation among themselves, especially if the different operators' line networks are spatially interwoven. The different forms of cooperation between operators and their benefits – they can be of particular use for the extension of cross-border lines into neighbouring networks – have been described in chapter 6.1.2.

Further improvements that can be achieved secondarily include improvements in the coordination of interchange possibilities across borders (with passengers crossing the border on foot, or vehicles crossing the border to serve one single stop beyond it). The proper indication of such interchange possibilities on network maps and in timetable search engines can already lead to enhanced utility for customers. Next steps would consist in guiding passengers between stops by in situ signalisation, by coordinating timetables, and eventually by connecting the services across the border.

8 Conclusion

8.1 Recapitulation of Key Results

8.1.1 Nature of Differences

The manifold differences between domestic and cross-border local public transport that represent the core of the research question of this project have proven to be a combination of various aspects. Some of these aspects are interrelated among each other, while others apply separately:

Starting from the complicated legal and regulatory framework, they also include the built environment with both irregular settlement structures and fewer transport infrastructures across borders, they further embrace administrative elements of authorities and operator companies, moreover consist in specific characteristics of customers, such as the demand structure (trip purposes, temporal distribution of demand) and the purchasing power, and not least, they comprise significant differences in the current service offers with less attractive fares and a low share of inhabitants being directly served by cross-border services.

Many of these aspects were observed not only to occur as differences between cross-border and domestic services, but also as differences among domestic services of nationally different agglomeration parts. These variations between areas of cross-border agglomerations can also be regarded as a result of the separate historical development and the respective national influences that lead to different standards and service principles.

As for cross-border transport connections on a local level, they have always been a result of political local and regional cross-border relations, which again were subject to the cross-border relations at a national level. Not by chance, the permeability of borders on a local and regional level was high at the time before the two World Wars, and accordingly manifold were transport interrelations. Through the advancement of the European integration, and the regionalisation developments in many countries, cross-border relations at a regional and local level have again been intensified in the last decades.

Still, modal shares of public transport within the considered agglomerations are much lower for relations across international borders than for domestic trips within the country of the agglomeration centre (as measured e.g. at cantonal, non-international borders within the agglomeration).

In the agglomerations of Geneva and Basel that have been analysed in more detail, the mix of trip purposes on cross-border journeys is clearly dominated by commuter trips by French and German residents to work in Switzerland. These trips occur in a temporally very concentrated

way, which leads to high demand peaks and renders the usage of transport infrastructures and rolling stock inefficient. Swiss residents represent a small minority on these cross-border services; most of them travel for leisure and shopping purposes and do rarely coincide with the commuter flows. This passenger group therefore has the potential to mitigate the strong demand peaks, thereby making the operation of public transport services more efficient.

In contrast to the various identified differences between cross-border and domestic services, some elements were also found that do not, or do only marginally, vary between cross-border and domestic cases. Notably the quality expectations of customers were found to be widely similar for cross-border and domestic trips. Also, when considering today's commercial transport speed, as one of the most important service elements, no structural difference between domestic and cross-border services can be discerned.

It may therefore be questioned why modal shares of cross-border public transport are still considerably lower than the domestic ones. The finding that quality expectations and standards of customers do not vary significantly suggests that similar modal shares could be achieved if equally attractive public transport services would be offered on cross-border relations.

While many of the identified factors tend to have an impeding effect on cross-border public transport, they may also lead to some advantages, such as additional trips caused by specific differences of the agglomeration parts, especially price and wage levels, but also the availability of housing, specific services and products.

8.1.2 Key Approaches

The approaches to overcome the identified difficulties which arise from international borders and apply to local public transport constitute the second part of the main research question of this project.

Although the study was not aimed at detailed technical or legal investigations, but rather at a functional analysis, unused potential for the development of the agglomerations' transport systems have been identified in both fields. A precondition to use this potential is a certain awareness of the border problem and its complexity, as well as a will, both among responsible persons and in the public, to overcome these shortcomings.

In a fist step, use should be made of the existing opportunities to render services more uniform and equally attractive:

- Adopt an active and uniform information strategy: Updated and accurate information about services throughout the agglomeration should be available from one source.
- Establish a corporate appearance of public transport to make passengers feel familiar with public transport services in all agglomeration parts.
- Create fair and simple fare systems: Use a well understandable range of fares that meets the needs of customers; tackle overpricing of cross-border fares; make the entire range of tickets available throughout the agglomeration and all available channels.

- Integrate cross-border services into the urban public transport network; improve network structures by connecting separate lines that terminate in the agglomeration centre to ‘diameter’ lines. For buses in the European Union, use can be made of liberalised cabotage regulations. In other countries, and for railways, obstacles can be overcome by means of cooperation between transport operators at either side of the border.
- Where cross-border trips are strongly dominated by work commuters, try to achieve a better mix of trip purposes (and thus a better temporal and directional distribution of demand) by attractively communicating leisure opportunities along routes, and by offering good connections to and from popular shopping locations.
- Implement fixed, institutionalised structures of cooperation between authorities, for both strategic and operational concerns. Legal bases to transfer such tasks from local and regional authorities to dedicated cross-border institutions have been created in most European countries.

Secondarily, in a longer-term perspective, the framework conditions for operating cross-border public transport services can be improved.

- Coordinate land use planning throughout the agglomeration, across administrative borders. Integrate land use and transport infrastructure planning.
- Improve interoperability between national networks; simplify cross-acceptance or common licensing in the railway sector, possibly granting simplified procedures for local / regional cross-border services.

While each of these approaches consists in a complex, lengthy process and may require resources, it is only their combination that can really make cross-border services more attractive and lead to higher modal shares. On the other hand, as there still exists a considerable potential for improvement in certain aspects, any step towards a more attractive system will have its positive repercussions. These are strongly needed in many cross-border agglomerations, in order to compensate the negative aspects of the national periphery with the advantages resulting from the proximity to neighbouring states.

8.2 Concluding Remarks and Perspectives for Further Research

8.2.1 Discussion of Applied Methods

The methodological approach that has been chosen has generally proved to be effective in dealing with the research interests of this study. It was based on four pillars: (a) findings and evidence from the literature; (b) the transformation, standardisation and subsequent combination of datasets from various sources; (c) the collection of empirical data and (d) the synthesis of the three previous pillars. This has made it possible to achieve novel results and findings.

Focussing on a set of case studies has allowed to study the research problem in great depth and to understand detailed characteristics and mechanisms. However, it has also caused certain restrictions in the generalisability of findings, as it is likely that certain conditions of other agglomerations are not congruent with those of the studied cases (cf. 8.2.2).

The questionnaire survey has proved very valuable for gaining new information and for treating rarely researched topics. The questionnaire consisted of 25 questions (most of which with subdivisions) and was thereby rather lengthy. By digitising and analysing the questionnaires, it has been realised that not all questions had been answered completely and reliably. However, the sample of questionnaires that has by far been large enough to ignore ambiguous answers as well as to analyse the various subgroups of respondents in detail made it possible to derive much information and many findings from this work package.

The spatial analysis that focused mainly on the relation between transport infrastructures, population distribution and the quantity of public transport services has proved as a valuable complement to the demand-related questionnaire data. Regarding the processing of data from various (thematically and territorially separate) sources, this has proved to be a complex and time-consuming process. Yet, this is also what made it unique and thus lead to new insights.

A potential for further methodological development in the given context might possibly consist in further statistical analyses of the collected data. These have so far been analysed with the goal of answering the research question and interests in a robust and reliable way, rather than furthering methodological knowledge. Therefore, for the given research design, the applied methods have performed well and satisfactorily.

8.2.2 Generalisability of Findings

The question of generalisability applies mainly to the thematic delimitations that have been made initially (chapter 2.1). Regarding other types of transport (private transport or long-distance public transport), the transferability potential of findings of this project is rather low. However, results may also be generalisable for other types of agglomerations. Here, three different categories can be distinguished:

(a) For other agglomerations of the same kind (i.e. fulfilling the delimitation criteria from chapter 2.1, but not considered as a case study here): To this type of agglomeration, the majority of findings can be transferred, even though they are likely not to be identically applicable. The fact that even the results from the case studies were of variable nature underlines the singularity of each individual agglomeration. Under consideration of the specific properties of a cross-border agglomeration – such as the specific functions of the border at this place, the topological situation as well as the respective repercussions on transportation – the findings of this study can be used accordingly.

(b) For other agglomerations across international borders that do not fulfil the definition of high-density agglomerations of chapter 2.1: While the same restrictions apply here as in (a), there are some additional limitations to the transferability of findings, particularly the distinct demand characteristics and transport infrastructures that render the task of providing comprehensive agglomeration-wide public transport services very different from high-density agglomerations. Yet, especially administrative and conceptual considerations of this study may well be of use for such agglomerations.

(c) For agglomerations across lower-level (i.e. non-international) borders: In these cases, the missing (or limited) differentness of the agglomeration parts at either side of borders clearly impairs the possibility of using findings from this study. Although some similar 'border symptoms' may be observed, the approaches to solve these problems are in many cases more simple than where international borders are present. Surely, the border may separate the responsibilities for a functionally coherent urban area, but the vertical distribution of responsibilities and the legal bases are in most cases similar on either side of borders, and the importance of the border effect on demand as well as of technical interoperability problems is expected to be much lower.

8.2.3 Success Factors

Various approaches have been formulated in this study to tackle impeding effects of international borders for local public transport (cf. 7.2). Three additional important factors support the cross-border development in a more universal way:

1. The awareness of the (justified) differentness of the situation beyond the border, of the difficulties incurred by the existence of these differences, of the potential benefits that the overcoming of these border discontinuities can bring, as well as of the resulting necessity to focus on border-related issues.
2. The establishment of trust and of informal networks among partners of either side of the border that makes it possible to confidently transfer certain competences (not the entire control) across borders.
3. The exploitation of advantages resulting from the border and the immediate proximity of two countries, which do not exist in domestic agglomerations.

8.2.4 Perspectives for Further Research

While the results of this study have revealed many findings, they have also opened many potential directions of further research in this field:

- How do the observed effects apply in agglomerations that are traversed by a lower-level (intra-national) border, or which are not as densely populated?
- What are the differences to agglomerations outside Europe, e.g. at the U.S.–Canadian border?
- What are the effects of international borders on regional public transport within transboundary regions, rather than local public transport in cross-border agglomerations?
- What are the economic benefits of fully integrated public transport systems in cross-border agglomerations?
- How have the different forms for institutionalised cross-border cooperation been applied? What findings can an ex-post evaluation of these cases reveal?
- Which legal or regulatory bases for cross-border cooperation are still missing and how could these gaps be filled?
- How does the psychological aspect of crossing borders impact the (mobility) behaviour of the population?

The research field can additionally be connected to neighbouring disciplines, such as sociology, political science, mechanical engineering, law, history, economy, linguistics and many more. The fact that the problem can be considered from many different scientific perspectives makes its exploration even more interesting.

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Appendix

A.1 Survey Details

A.1.1 Questionnaire Version for Buses in Geneva (French)

TAC tpg ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Chère passagère, cher passager,

Afin de mieux connaître vos besoins et vos habitudes en matière de transports publics, l'École polytechnique fédérale de Zurich (ETH Zurich) procède à une **enquête** en coopération avec les entreprises de transport susmentionnées.

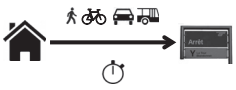
Votre participation nous est très précieuse. Elle permettra d'améliorer l'offre de façon ciblée et selon vos besoins, en tenant compte notamment de la situation transfrontalière de l'agglomération franco-valdo-genevoise. Toutes vos indications seront traitées de manière anonyme et ne permettront pas de vous identifier.

Le remplissage du questionnaire dure environ **dix minutes**. Nous vous remercions d'avance de votre participation.

Veuillez retourner le questionnaire complété directement à la personne qui vous l'a remis ou utilisez l'enveloppe internationale libre-réponse ci-jointe.

1. À quel arrêt êtes-vous monté ?
_____

2. D'où êtes-vous arrivé à cet arrêt ? *(p.ex. une adresse / un magasin, svp.)*
_____



3. Comment êtes-vous arrivé à cet arrêt ? *(plusieurs réponses possibles)*
☐ à pied ☐ en bus / tram ☐ en voiture (conducteur) / moto ☐ autrement :
☐ à vélo ☐ en train ☐ en voiture (passager) / taxi _____

4. Combien de temps vous a-t-il fallu pour arriver à cet arrêt ?
____ minutes

5. À quel arrêt descendrez-vous ?
_____

6. Quelle est la destination de votre voyage ?
(p.ex. une adresse / un point d'intérêt / un magasin, svp.)
_____

7. Comment poursuivrez-vous votre voyage ?
(plusieurs réponses possibles)
☐ à pied ☐ en bus / tram ☐ en voiture (conducteur) / moto ☐ autrement :
☐ à vélo ☐ en train ☐ en voiture (passager) / taxi _____

8. Combien de temps cela vous prendra-t-il ?
____ minutes

*Dans les questions suivantes, nous allons examiner plus précisément **votre voyage sur ce trajet**.*

9. Avec quel titre de transport voyagez-vous à present ? *(une seule réponse, svp.)*
☐ billet plein tarif ☐ abonnement ☐ carte journalière
☐ billet combiné avec un abonnement ☐ carte multicourses ☐ autre : _____

10. Faites-vous aujourd'hui un trajet aller-retour en bus ? *(une seule réponse, svp.)*

☐ oui ☐ non

11. Quelle est la raison principale de votre voyage ? *(une seule réponse, svp.)*

- ☐ achat de denrées alimentaires
- ☐ achat d'autres marchandises
- ☐ achat d'articles divers choisis spontanément

↳ **continuez à la question 12a**

- ☐ trajet du / au travail
- ☐ trajet professionnel
- ☐ éducation
- ☐ autre: _____

↳ **continuez à la question 13**

- ☐ loisirs (sauf achats)

↳ **continuez à la question 12b**

12a. Pourquoi faites-vous vos achats à cet endroit ?
(max. 2 réponses, svp.)

- ☐ magasin le plus proche
- ☐ assortiment différent
- ☐ des prix meilleur marché
- ☐ meilleure qualité
- ☐ des heures d'ouverture plus favorables
- ☐ meilleur service
- ☐ pour essayer / sur recommandation
- ☐ autre raison : _____

↳ **continuez à la question 13**

12b. Pourquoi passez-vous vos loisirs à cet endroit ?
(max. 2 réponses, svp.)

- ☐ rencontre avec quelqu'un
- ☐ activité de loisir désirée peut être exercée mieux à cet endroit
- ☐ offre de loisir désirée n'existe qu'à cet endroit (et non pas au point de départ)
- ☐ des prix meilleur marché
- ☐ pour essayer / sur recommandation
- ☐ autre raison : _____

↳ **continuez à la question 13**

13. À quelle fréquence faites-vous ce trajet en bus ?

☐ environ _____ jours par _____ *(p.ex. 2 jours par semaine / 3 jours par an)* ☐ presque jamais

14. Quand avez-vous pris le bus pour la première fois sur ce trajet ? *(une seule réponse, svp.)*

☐ il y a plus de 5 ans ☐ il y a 1 à 5 ans ☐ il y a 1 à 11 mois ☐ il y a moins de 1 mois ☐ aujourd'hui

15. Depuis combien de temps connaissiez-vous l'offre de bus sur ce trajet ? *(1 seule réponse, svp.)*

☐ plus de 5 ans ☐ 1 à 5 ans ☐ 1 à 11 mois ☐ moins de 1 mois ☐ aujourd'hui

16. Faites-vous parfois ce trajet avec d'autres moyens de transport ?

autres lignes de transports publics		☐ non, (presque) jamais ☐ oui, env. ____ jours par _____
à pied		☐ non, (presque) jamais ☐ oui, env. ____ jours par _____
à vélo		☐ non, (presque) jamais ☐ oui, env. ____ jours par _____
en voiture (conducteur) / moto		☐ non, (presque) jamais ☐ oui, env. ____ jours par _____
en voiture (passager) / taxi		☐ non, (presque) jamais ☐ oui, env. ____ jours par _____

17. Pourquoi avez-vous choisi de prendre le bus aujourd'hui ? *(plusieurs réponses possibles)*

☐ pas de voiture / vélo / moto à disposition, pas de permis de conduire ou pas d'entraînement ☐ parking ☐ gain de temps ☐ économie financière ☐ météo ☐ accompagnement ☐ _____

18. De quoi devez-vous vous informer avant d'emprunter cette ligne de bus ?

« Avant un déplacement sur cette ligne, je...	... **ne** dois **plus** m'informer (1)	... dois **parfois** m'informer (2)	... dois **souvent** m'informer (3)	... dois **toujours** m'informer (4)
sur les arrêts desservis	☐	☐	☐	☐
sur l'horaire	☐	☐	☐	☐
sur le prix / tarif	☐	☐	☐	☐

19. Dans quelle mesure cette offre de bus satisfait-elle vos besoins ?

	pas du tout (1)	mal (2)	moyen (3)	bien (4)	idéal (5)	pas de réponse
Horaire (premier / dernier train)	☐	☐	☐	☐	☐	☐
Fréquence	☐	☐	☐	☐	☐	☐
Prix	☐	☐	☐	☐	☐	☐
Arrêts desservis	☐	☐	☐	☐	☐	☐
Durée du trajet	☐	☐	☐	☐	☐	☐
Fiabilité	☐	☐	☐	☐	☐	☐
Confort	☐	☐	☐	☐	☐	☐
Sécurité	☐	☐	☐	☐	☐	☐
Impression générale	☐	☐	☐	☐	☐	☐

Remarques : _____

_____

Vous avez déjà répondu à ¾ des questions.

*Nous terminons par quelques questions sur **l'utilisation que vous faites de l'offre globale** des transports publics dans l'agglomération franco-valdo-genevoise.*

*Nous vous prions de distinguer entre vos **trajets transfrontaliers** (traversant des frontières nationales) et vos **trajets intérieurs** (sans frontières nationales).*

20. À quelle fréquence empruntez-vous les transports publics de l'agglomération franco-valdo-genevoise ?

Tram et bus pour trajets intérieurs		☐ (presque) jamais	☐ env. ____ jours par _____
Trains RER et TER pour trajets intérieurs		☐ (presque) jamais	☐ env. ____ jours par _____
Bus pour trajets transfrontaliers		☐ (presque) jamais	☐ env. ____ jours par _____
Trains RER et TER pour trajets transfrontaliers		☐ (presque) jamais	☐ env. ____ jours par _____

21. De quoi devez-vous vous informer avant un déplacement ?

a. Tram et bus pour trajets intérieurs

« Avant un déplacement, je...	... **ne** dois **plus** m'informer (1)	... dois **parfois** m'informer (2)	... dois **souvent** m'informer (3)	... dois **toujours** m'informer (4)
sur les arrêts desservis	☐	☐	☐	☐
sur l'horaire	☐	☐	☐	☐
sur le prix / tarif	☐	☐	☐	☐

b. Trains RER et TER pour trajets intérieurs

« Avant un déplacement, je...	... **ne** dois **plus** m'informer (1)	... dois **parfois** m'informer (2)	... dois **souvent** m'informer (3)	... dois **toujours** m'informer (4)
sur les gares desservies	☐	☐	☐	☐
sur l'horaire	☐	☐	☐	☐
sur le prix / tarif	☐	☐	☐	☐

Continué à la page suivante...

Suite de la question 21

c. Bus pour trajets transfrontaliers

« Avant un déplacement, je...	... **ne** dois **plus** m'informer (1)	... dois **parfois** m'informer (2)	... dois **souvent** m'informer (3)	... dois **toujours** m'informer (4)
sur les arrêts desservis	☐	☐	☐	☐
sur l'horaire	☐	☐	☐	☐
sur le prix / tarif	☐	☐	☐	☐

d. Trains RER et TER pour trajets transfrontaliers

« Avant un déplacement, je...	... **ne** dois **plus** m'informer (1)	... dois **parfois** m'informer (2)	... dois **souvent** m'informer (3)	... dois **toujours** m'informer (4)
sur les gares desservies	☐	☐	☐	☐
sur l'horaire	☐	☐	☐	☐
sur le prix / tarif	☐	☐	☐	☐

22. Comment vous informez-vous pour les trajets transfrontaliers ? *(plusieurs réponses possibles)*

Oralement	Par écrit	Par internet
☐ auprès du conducteur / contrôleur	☐ affiche à l'arrêt	☐ en ligne sur : _____
☐ au guichet	☐ horaires imprimés	_____
☐ renseignements téléphoniques	☐ dépliants / plan de ville	_____
☐ auprès d'autres passagers	☐ autrement :	☐ téléphone portable / ordiphone sur :
☐ auprès d'amis / de la famille	_____	_____
☐ autrement : _____		_____

23. De combien de voitures dispose votre ménage ? *(une seule réponse, svp.)*

☐ aucune ☐ moins de 1 par adulte ☐ 1 par adulte ☐ plus de 1 par adulte

24. Quel est votre lieu de domicile ?
(avec code postal, svp.)

_____ _____

25. Veuillez nous indiquer votre âge.

_____ ans

Merci beaucoup de votre participation ! Veuillez rendre le questionnaire complété à la personne qui vous l'a remis ou utiliser l'enveloppe internationale libre-réponse ci-jointe.

Pour plus d'information sur le projet de recherche, visitez notre site web : http://url.ethz.ch/crossborder

Very similar questionnaire versions have been distributed on buses in Basel (both in French and German), but e.g. with different transport operator logos in the heading.

A.1.2 Questionnaire Version for Trains in Basel (German)

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Sehr geehrter Fahrgast

Um Ihre Gewohnheiten und Ihre Bedürfnisse bezüglich öffentlichem Verkehr besser kennen zu lernen, führt die ETH Zürich in Zusammenarbeit mit den aufgeführten Transportunternehmen eine **Fahrgastbefragung** durch.

Ihre Teilnahme ist uns sehr wertvoll. Sie ermöglicht es, das Angebot gezielt und nach Ihren Bedürfnissen zu optimieren. Dem grenzüberschreitenden Charakter der Agglomeration Basel wird dabei besonders Rechnung getragen. Ihre Angaben für diese Umfrage werden anonym behandelt und lassen keine Rückschlüsse auf Ihre Person zu.

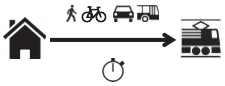
Das Ausfüllen des Fragebogens dauert **ca. 10 Minuten. Vielen Dank für Ihre Mithilfe!**

Sie haben ausserdem die Möglichkeit, am **Wettbewerb** teilzunehmen und attraktive Preise zu gewinnen!

Bitte geben Sie den ausgefüllten Fragebogen direkt im Zug an die verteilende Person zurück, oder werfen Sie ihn im beiliegenden Umschlag in den nächsten Briefkasten.

1. An welchem Bahnhof sind Sie eingestiegen?
_____

2. Woher kamen Sie zum Bahnhof? *(z.B. Angabe einer Adresse / eines Ladens)*
_____



3. Wie haben Sie den Bahnhof erreicht? *(mehrere Antworten wählbar)*
☐ zu Fuss ☐ Bus / Tram ☐ Auto (Fahrer) / Motorrad ☐ anders:
☐ Fahrrad ☐ Bahn ☐ Auto (Passagier) / Taxi _____

4. Wie lange brauchten Sie für diesen Weg zum Bahnhof?
____ Minuten

5. An welchem Bahnhof werden Sie aussteigen?
_____

6. Wo ist das Ziel Ihrer Reise? *(z.B. Adresse / Sehenswürdigkeit / Laden)*
_____

7. Wie werden Sie nach dem Ausstieg Ihr Ziel erreichen?
(mehrere Antworten wählbar)
☐ zu Fuss ☐ Bus / Tram ☐ Auto (Fahrer) / Motorrad ☐ anders:
☐ Fahrrad ☐ Bahn ☐ Auto (Passagier) / Taxi _____

8. Wie lange werden Sie dafür brauchen?
____ Minuten

*In den nächsten Fragen möchten wir **Ihre Reise auf dieser Strecke** etwas genauer betrachten.*

9. Mit welchem Fahrausweis sind Sie jetzt unterwegs? *(bitte nur 1 Antwort)*
☐ Einzelfahrschein ohne Ermässigung ☐ Abonnement / Zeitkarte ☐ Tageskarte
☐ Einzelfahrschein in Kombination mit Abonnement / Zeitkarte ☐ Mehrfahrtenkarte / Punkte Card ☐ anderer: _____

10. Fahren Sie heute mit dem Zug auf demselben Weg hin und zurück? *(bitte nur 1 Antwort)*

☐ ja ☐ nein

11. Welches ist der Hauptgrund Ihrer Reise? *(bitte nur 1 Antwort)*

☐ Einkauf von Lebensmitteln	☐ Arbeitsweg	☐ Freizeit (ohne Einkauf)
☐ Einkauf von anderen Waren	☐ Berufliche Fahrt (Arbeitszeit)	
☐ Einkauf von diversen, spontan ausgewählten Artikeln	☐ Ausbildung / Schule	
	☐ anderer: _____	
↳ **weiter bei Frage 12a**	↳ **weiter bei Frage 13**	↳ **weiter bei Frage 12b**

12a. Aus welchem Grund führen Sie den Einkauf an diesem Ort durch?
(max. 2 Antworten)

☐ nächstgelegene Einkaufsmöglichkeit
☐ anderes Sortiment
☐ günstigere Preise
☐ bessere Qualität
☐ bessere Öffnungszeiten
☐ bessere Beratung / Bedienung
☐ zum Ausprobieren / auf Empfehlung
☐ anderer Grund: _____

↳ **weiter bei Frage 13**

12b. Aus welchem Grund verbringen Sie Ihre Freizeit an diesem Ort?
(max. 2 Antworten)

☐ treffe dort jemanden
☐ gewünschte Freizeitaktivität kann dort besser ausgeübt werden
☐ gewünschtes Freizeitangebot existiert nur dort (und nicht beim Ausgangspunkt)
☐ günstigere Preise
☐ zum Ausprobieren / auf Empfehlung
☐ anderer Grund: _____

↳ **weiter bei Frage 13**

13. Wie oft fahren Sie im Zug auf dieser Strecke?

☐ an etwa _____ Tagen pro _____ *(z.B. an 2 Tagen pro Woche / 3 Tagen pro Jahr)* ☐ fast nie

14. Wann sind Sie zum ersten Mal mit dem Zug auf dieser Strecke gefahren? *(bitte nur 1 Antwort)*

☐ vor mehr als 5 Jahren ☐ vor 1-5 Jahren ☐ vor 1-11 Monaten ☐ vor weniger als 1 Monat ☐ heute

15. Wie lange wussten Sie schon vom Bahn-Angebot auf dieser Strecke? *(bitte nur 1 Antwort)*

☐ seit mehr als 5 Jahren ☐ seit 1-5 Jahren ☐ seit 1-11 Monaten ☐ seit weniger als 1 Monat ☐ seit heute

16. Legen Sie diese Strecke manchmal auch mit anderen Verkehrsmitteln zurück?

andere öV-Linien	☐ nein, (fast) nie	☐ ja, an etwa _____	Tagen pro _____
zu Fuss	☐ nein, (fast) nie	☐ ja, an etwa _____	Tagen pro _____
Fahrrad	☐ nein, (fast) nie	☐ ja, an etwa _____	Tagen pro _____
Auto (Fahrer) / Motorrad	☐ nein, (fast) nie	☐ ja, an etwa _____	Tagen pro _____
Auto (Passagier) / Taxi	☐ nein, (fast) nie	☐ ja, an etwa _____	Tagen pro _____

17. Warum haben Sie sich heute für den Zug entschieden? *(mehrere Antworten wählbar)*

☐ kein Auto / Fahrrad / Motorrad zur Verfügung bzw. kein Führerschein oder keine Übung ☐ Parkplatz ☐ Zeitgewinn ☐ finanzielle Überlegung ☐ Wetter ☐ Begleitung ☐ _____

18. Worüber müssen Sie sich vor einer Fahrt auf dieser Bahnlinie jeweils informieren?

«Vor einer Fahrt auf dieser Linie muss ich mich...	**nicht mehr** informieren (1)	**manchmal** informieren (2)	**meistens** informieren (3)	**immer** informieren (4)
bezüglich bediente Bahnhöfe	☐	☐	☐	☐
bezüglich Fahrplan	☐	☐	☐	☐
bezüglich Fahrpreis / Tarife	☐	☐	☐	☐

19. Wie sehr deckt das Angebot dieser Bahnlinie Ihre Bedürfnisse ab?

	gar nicht (1)	schlecht (2)	mittel (3)	gut (4)	ideal (5)	keine Angabe
Betriebszeiten (erste / letzte Fahrt)	☐	☐	☐	☐	☐	☐
Häufigkeit / Takt	☐	☐	☐	☐	☐	☐
Preis	☐	☐	☐	☐	☐	☐
Bediente Bahnhöfe	☐	☐	☐	☐	☐	☐
Reisezeit	☐	☐	☐	☐	☐	☐
Zuverlässigkeit	☐	☐	☐	☐	☐	☐
Komfort	☐	☐	☐	☐	☐	☐
Sicherheit	☐	☐	☐	☐	☐	☐
Gesamteindruck	☐	☐	☐	☐	☐	☐

Bemerkungen: _____

_____

¾ der Fragen haben Sie bereits beantwortet.

*Zum Schluss wenden wir uns noch **Ihrer Benutzung des gesamten Angebots** des öffentlichen Verkehrs in der trinationalen Agglomeration Basel zu.*

*Dabei unterscheiden wir Ihre **grenzüberschreitenden Fahrten** (d.h. über Landesgrenzen) vom **Binnenverkehr** (d.h. ohne Überschreitung von Landesgrenzen).*

20. Wie oft benützen Sie den öffentlichen Verkehr in der trinationalen Agglomeration Basel?

Tram und Bus im Binnenverkehr	☐ (fast) nie	☐ an etwa _____ Tagen pro	_____
S-Bahn im Binnenverkehr	☐ (fast) nie	☐ an etwa _____ Tagen pro	_____
Bus für grenzüberschreitende Fahrt	☐ (fast) nie	☐ an etwa _____ Tagen pro	_____
S-Bahn für grenzüberschreitende Fahrt	☐ (fast) nie	☐ an etwa _____ Tagen pro	_____

21. Worüber müssen Sie sich vor einer Fahrt informieren?

a. Tram + Bus im Binnenverkehr

«Vor einer Fahrt muss ich mich...	**nicht mehr** informieren (1)	**manchmal** informieren (2)	**meistens** informieren (3)	**immer** informieren (4)
bezüglich bediente Haltestellen	☐	☐	☐	☐
bezüglich Fahrplan	☐	☐	☐	☐
bezüglich Fahrpreis / Tarife	☐	☐	☐	☐

b. S-Bahn im Binnenverkehr

«Vor einer Fahrt muss ich mich...	**nicht mehr** informieren (1)	**manchmal** informieren (2)	**meistens** informieren (3)	**immer** informieren (4)
bezüglich bediente Bahnhöfe	☐	☐	☐	☐
bezüglich Fahrplan	☐	☐	☐	☐
bezüglich Fahrpreis / Tarife	☐	☐	☐	☐

Fortsetzung der Frage auf der nächsten Seite...

Fortsetzung der Frage 21

c. Bus für grenzüberschreitende Fahrt

«Vor einer Fahrt muss ich mich...	**nicht mehr** informieren (1)	**manchmal** informieren (2)	**meistens** informieren (3)	**immer** informieren (4)
bezüglich bediente Haltestellen	☐	☐	☐	☐
bezüglich Fahrplan	☐	☐	☐	☐
bezüglich Fahrpreis / Tarife	☐	☐	☐	☐

d. S-Bahn für grenzüberschreitende Fahrt

«Vor einer Fahrt muss ich mich...	**nicht mehr** informieren (1)	**manchmal** informieren (2)	**meistens** informieren (3)	**immer** informieren (4)
bezüglich bediente Bahnhöfe	☐	☐	☐	☐
bezüglich Fahrplan	☐	☐	☐	☐
bezüglich Fahrpreis / Tarife	☐	☐	☐	☐

22. Auf welchem Weg holen Sie diese Informationen für grenzüberschreitende Fahrten ein?
(mehrere Antworten wählbar)

mündlich	schriftlich	Internet
☐ beim Chauffeur / Schaffner	☐ Aushang an Haltestelle	☐ am Computer unter: _____
☐ am Schalter	☐ gedruckte Fahrpläne	_____
☐ telefonische Auskunft	☐ Prospekte / Stadtplan	_____
☐ bei anderen Fahrgästen	☐ anders: _____	☐ am Mobiltelefon / Smartphone unter:
☐ bei Freunden / Familie		_____
☐ anders: _____		_____

23. Wie viele Autos stehen in Ihrem Haushalt zur Verfügung? *(bitte nur 1 Antwort)*
☐ keines ☐ weniger als 1 pro Erwachsene(n) ☐ 1 pro Erwachsene(n) ☐ Mehr als 1 pro Erwachsene(n)

24. In welcher Gemeinde wohnen Sie? *(bitte mit Postleitzahl)*
_____ _____

25. Bitte geben Sie Ihr Alter an.
_____ Jahre

Vielen Dank für Ihre Auskunft! Bitte geben Sie den ausgefüllten Fragebogen der verteilenden Person zurück oder benützen Sie den beiliegenden Umschlag (international kostenlos gültig).

Für weitere Informationen zum Forschungsprojekt besuchen Sie bitte die Webseite http://url.ethz.ch/grenzueberschreitend

Wettbewerb
1. Preis: BVB Tischuhr
2.-3. Preis: TicketTriRegio (grenzüberschreitende Tageskarte) und TNW Tageskarte
4.-5. Preis: TicketTriRegio mini (grenzüberschreitende Tageskarte) und TNW Tageskarte
6.-10. Preis: BVBär oder Bauchtasche nach Wahl, in Kombination mit einer TNW Tageskarte
Die Preise wurden zur Verfügung gestellt von den Basler Verkehrsbetrieben BVB.

Für die Teilnahme am Wettbewerb, geben Sie bitte Ihren Namen und Ihre Adresse an.

_____

_____

Teilnahmeschluss: 11. November 2011.
Die Gewinner werden per Post benachrichtigt. Ihre Angaben für den Wettbewerb werden vertraulich behandelt, nicht mit der obenstehenden Umfrage in Verbindung gebracht und nicht an Dritte weitergegeben. Mitarbeiter der beteiligten Transportunternehmen sowie der ETH Zürich sind nicht teilnahmeberechtigt. Keine Barauszahlung der Preise. Der Rechtsweg ist ausgeschlossen. Über den Wettbewerb wird keine Korrespondenz geführt.

The identical questionnaire was also distributed in French and a very similar version (French) was distributed in Geneva, but e.g. with different transport operator logos in the heading.

A.1.3 Sample of Survey Respondents

Table A 1: Number of Survey Respondents per Line

Line	Number of Respondents in Domestic Traffic	Number of Respondents in Cross-Border Traffic	Number of Cross-Border Passengers according to passenger counts	Share of Cross-Border Passengers covered by Survey
Bus BS 1 (CH-D)	25	58 (1)	1'584 **	3.7%
Bus BS 2 (CH-D)	63	85	530 **	16.0%
Bus BS 3 (CH-D)	28	127	440 **	28.9%
Bus BS 4 (CH-F)	26	117	789 **	14.8%
Bus GE 1 (CH-F)	22	86	1'230 (2) *	7.0%
Bus GE 2 (CH-F)	117	173	1'410 (2) *	12.3%
Bus GE 3 (CH-F)	54	299	1'900 (2) *	15.7%
Train BS 1 (CH-F)	59	316	2'107 **	15.0%
Train BS 2 (CH)	297	0	0	–
Train BS 3 (CH-D)	288	558	4'440 **	12.6%
Train GE 1 (CH-F)	534	136	700 *	19.4%
Train GE 2 (CH-F)	2	427	1'000 *	42.7%
All considered lines	1'515	2'382	16'130 */**	14.6%

(1) Includes 26 passengers with origin and destination in Germany but crossing Swiss territory (elsewhere considered as domestic passengers)

(2) Includes other bus lines at the same border crossing

* Source: Citec Ingénieurs Conseils SA (2012)

** Source: PTV France (2012) (counts apply to passengers between 6h and 20h only)

Source of remaining numbers: Own Survey (2011), cf. chapter 4.3

Table A 2: Number of Survey Respondents per Country of Residence

Agglomeration	Country of Residence	Number of Respondents	Relative Share of Respondents (among all Respondents)	Population in Agglomeration Section	Relative Share of Respondents (among Population)
Basel	France	472	23%	34'581	0.014%
	Germany	1'023	51%	129'945	0.008%
	Switzerland	524	26%	445'857	0.001%
Geneva	France	1'175	65%	111'328	0.011%
	Switzerland	630	35%	426'401	0.001%
Geneva + Basel	France	1'647	43%	145'909	0.011%
	Germany	1'023	27%	129'945	0.008%
	Switzerland	1'154	30%	872'258	0.001%

Source of Population Numbers (Year of Reference: 2006): Basel: SIGRS / GISOR – Conférence du Rhin Supérieur / Oberrheinkonferenz; Geneva: Recensements de la Population (INSEE) and STATPOP (© Swiss Federal Statistical Office).

Source of remaining numbers: Own Survey (2011), cf. chapter 4.3

Table A 3: Number of Survey Respondents per Age

Age	Number of Respondents			Relative Share of Respondents		
	Basel	Geneva	Total	Basel	Geneva	Total
< 20	161	224	385	8%	12%	10%
20 – 29	376	466	842	19%	26%	22%
30 – 39	296	429	725	15%	24%	19%
40 – 49	436	319	755	22%	17%	20%
50 – 59	404	240	644	20%	13%	17%
≥ 60	359	167	526	18%	9%	14%

Source: Own Survey (2011), cf. chapter 4.3

Table A 4: Passenger Characteristics Per per Line

Line	N	Cross-Border Riders [%]	Period Ticket Holders (>1d) [%]	Evening Peak (17-19h) Riders [%]	Trip Purposes [%]			
					Work / Pro-fessional	Educa-tion	Shopping	Leisure, Other
Bus BS 1 (CH-D)	83	38.6	55.4	27.7	37.8	14.6	28.0	19.5
Bus BS 2 (CH-D)	148	57.4	75.0	37.2	44.5	15.1	21.9	18.5
Bus BS 3 (CH-D)	155	81.9	60.0	27.7	40.3	11.7	17.5	30.5
Bus BS 4 (CH-F)	143	81.8	50.3	30.8	47.2	9.2	28.2	15.5
Bus GE 1 (CH-F)	108	79.6	67.6	40.7	67.0	14.2	4.7	14.2
Bus GE 2 (CH-F)	290	59.7	72.4	32.8	52.2	14.2	11.4	22.1
Bus GE 3 (CH-F)	353	84.7	64.0	37.7	55.1	22.4	8.5	13.9
Train BS 1 (CH-F)	375	84.3	80.5	54.9	82.4	6.9	1.9	8.8
Train BS 2 (CH)	297	0.0	79.8	26.6	45.2	16.8	8.2	29.8
Train BS 3 (CH-D)	846	66.0	75.2	35.6	65.6	15.0	5.9	13.5
Train GE 1 (CH-F)	670	20.3	82.1	53.6	71.8	9.2	5.7	13.4
Train GE 2 (CH-F)	429	99.5	80.2	71.8	80.0	12.4	1.4	6.3
Total	3'897	60.5	74.4	43.4	63.4	13.3	8.1	15.2

Source: Own Survey (2011), cf. chapter 4.3

A.2 Complementary Data

A.2.1 Characteristics of Communes within Agglomeration Perimeters

Table A 5: Characteristics of Communes within Geneva Agglomeration Perimeter

Name	Country	Population	Area (except lake) [ha]	Population Density [ha^{-1}]
Ambilly	F	5'728	125	45.82
Anières	CH	2'204	386	5.71
Annemasse	F	28'572	498	57.37
Bardonnex	CH	2'115	500	4.23
Bellevue	CH	2'841	435	6.53
Bernex	CH	9'316	1'295	7.19
Bogis-Bossey	CH	880	245	3.59
Carouge (GE)	CH	18'884	270	69.94
Cessy	F	3'233	639	5.06
Chavannes-de-Bogis	CH	1'061	286	3.71
Chêne-Bougeries	CH	10'061	414	24.30
Chêne-Bourg	CH	7'648	128	59.75
Collonge-Bellerive	CH	7'029	612	11.49
Collonges-sous-Salève	F	3'514	613	5.73
Cologny	CH	4'894	367	13.34
Commugny	CH	2'667	653	4.08
Confignon	CH	3'447	277	12.44
Coppet	CH	2'729	187	14.59
Corsier (GE)	CH	1'728	274	6.31
Cranves-Sales	F	4'973	1'361	3.65
Crassier	CH	997	203	4.91
Etrembières	F	1'639	543	3.02
Ferney-Voltaire	F	7'661	478	16.03
Founex	CH	2'935	479	6.13
Gaillard	F	11'507	402	28.62
Genève	CH	178'722	1'593	112.19
Genthod	CH	2'551	287	8.89
Hermance	CH	896	144	6.22
Lancy	CH	26'905	477	56.40
Le Grand-Saconnex	CH	9'736	438	22.23
Meyrin	CH	19'661	994	19.78
Mies	CH	1'632	345	4.73
Onex	CH	17'167	281	61.09
Ornex	F	3'053	564	5.41
Perly-Certoux	CH	2'736	254	10.77
Plan-les-Ouates	CH	8'794	585	15.03
Pregny-Chambésy	CH	3'389	324	10.46
Prévessin-Moëns	F	4'811	1'207	3.99
Puplinge	CH	2'123	267	7.95
Saint-Genis-Pouilly	F	7'865	977	8.05
Saint-Julien-en-Genevois	F	11'019	1059	10.41
Sauverny	F	1'118	189	5.92
Ségny	F	1'512	324	4.67
Tannay	CH	1'382	182	7.51
Thônex	CH	13'092	382	34.27
Troinex	CH	2'167	343	6.32
Vandoeuvres	CH	2'571	442	5.82
Vernier	CH	30'020	769	39.04
Versoix	CH	11'868	1051	7.83
Versonnex	F	2'027	589	3.44
Vétraz-Monthoux	F	6'141	711	8.64
Veyrier	CH	9'553	650	14.70
Ville-la-Grand	F	6'955	449	15.49

Year of Reference: 2006; Sources: Switzerland: STATPOP (© Swiss Federal Statistical Office); France: Recensements de la population (INSEE)

Table A 6: Characteristics of Communes within Basel Agglomeration Perimeter

Name	Country	Population	Area [ha]	Population Density [ha^{-1}]
Aesch (BL)	CH	9'927	732	13.55
Allschwil	CH	18'397	891	20.65
Arlesheim	CH	8'869	696	12.74
Augst	CH	905	158	5.71
Basel	CH	163'081	2'390	68.23
Bättwil	CH	1'172	167	7.01
Bettingen	CH	1'199	221	5.44
Biel-Benken	CH	3'026	413	7.33
Binningen	CH	14'238	445	31.97
Binzen	D	2'878	581	4.96
Birsfelden	CH	10'257	252	40.72
Böckten	CH	742	228	3.25
Bottmingen	CH	5'670	299	18.96
Bubendorf	CH	4'303	1'079	3.99
Diepflingen	CH	534	143	3.75
Dornach	CH	6'053	576	10.50
Eimeldingen	D	2'352	354	6.64
Ettingen	CH	4'819	634	7.60
Frenkendorf	CH	6'078	459	13.25
Füllinsdorf	CH	4'288	461	9.29
Gelterkinden	CH	5'566	979	5.68
Giebenach	CH	959	128	7.48
Grellingen	CH	1'694	329	5.15
Grenzach-Wyhlen	D	13'631	1'726	7.90
Hégenheim	F	2'926	694	4.22
Hofstetten-Flüh	CH	2'922	749	3.90
Hölstein	CH	2'271	608	3.74
Huningue	F	6'358	284	22.38
Itingen	CH	1'800	319	5.64
Kaiseraugst	CH	4'793	497	9.65
Lausen	CH	4'746	556	8.54
Liestal	CH	13'128	1'818	7.22
Lörrach	D	47'438	3'938	12.05
Lupsingen	CH	1'311	311	4.22
Möhlin	CH	9'070	1'880	4.82
Münchenstein	CH	11'601	721	16.08
Muttenz	CH	16'895	1'658	10.19
Niederdorf	CH	1'754	442	3.96
Oberdorf (BL)	CH	2'304	622	3.71
Oberwil (BL)	CH	10'169	789	12.89
Pfeffingen	CH	2'140	495	4.33
Pratteln	CH	14'869	1'074	13.85
Ramlinsburg	CH	703	220	3.20
Reinach (BL)	CH	18'572	695	26.73
Rheinfelden	CH	10'870	1'607	6.76
Rheinfelden (Baden)	D	32'469	6'280	5.17
Riehen	CH	20'542	1'091	18.84
Rosenau	F	1'970	636	3.10
Rümmingen	D	1'658	446	3.72
Saint-Louis	F	19'875	1'699	11.70
Schönenbuch	CH	1'429	137	10.46
Seltisberg	CH	1'316	356	3.69
Sissach	CH	5'710	884	6.46
Tecknau	CH	825	236	3.50
Therwil	CH	9'307	766	12.15
Thürnen	CH	1'206	225	5.36
Village-Neuf	F	3'452	679	5.08
Weil am Rhein	D	29'519	1'952	15.13
Witterswil	CH	1'342	267	5.02
Zunzgen	CH	2'485	691	3.60

Year of Reference: 2006

Source: GISOR/SIGRS Oberhheinkonferenz / Conférence du Rhin Supérieur

Table A 7: Characteristics of Communes within Strasbourg Agglomeration Perimeter

Name	Country	Population	Area [ha]	Population Density [ha^{-1}]
Bischheim	F	17'827	443	40.29
Brumath	F	9'737	3'112	3.13
Eckbolsheim	F	6'347	562	11.29
Eschau	F	4'758	1'179	4.04
Fegersheim	F	5'104	630	8.10
Geispolsheim	F	7'073	2'209	3.20
Hangenbieten	F	1'476	422	3.50
Hoenheim	F	10'616	341	31.15
Holtzheim	F	2'974	687	4.33
Illkirch-Graffenstaden	F	26'368	2'219	11.88
Kehl	D	34'700	7'514	4.62
Lampertheim	F	3'058	689	4.44
Lingolsheim	F	16'784	573	29.29
Lipsheim	F	2'479	492	5.04
Mittelhausbergen	F	1'775	172	10.31
Mundolsheim	F	5'050	426	11.86
Niederhausbergen	F	1'352	310	4.36
Oberhausbergen	F	4'397	377	11.65
Ostwald	F	10'666	711	15.00
Reichstett	F	4'558	803	5.67
Schiltigheim	F	31'239	761	41.03
Souffelweyersheim	F	6'219	460	13.52
Strasbourg	F	272'975	7'800	35.00
Vendenheim	F	5'670	1'621	3.50
Wolfisheim	F	3'930	570	6.90

Year of Reference: 2006

Source: GISOR/SIGRS Oberhheinkonferenz / Conférence du Rhin Supérieur

Table A 8: Characteristics of Communes within Lille Agglomeration Perimeter

Name	Country	Population	Area [ha]	Population Density [ha^{-1}]
ALLENNES-LES-MARAIS	F	3'327	555	5.99
ANNOEULLIN	F	9'592	901	10.65
ANSTAING	F	1'313	230	5.71
ANZEGEM	B	14'471	4'179	3.46
ARMENTIERES	F	25'704	628	40.93
ATTICHES	F	2'290	668	3.43
AVELGEM	B	9'641	2'175	4.43
BONDUES	F	9'816	1'305	7.52
BOUSBECQUE	F	4'700	644	7.30
CAPINGHEM	F	1'645	186	8.84
CHERENG	F	3'001	418	7.18
COMINES	F	12'637	1'602	7.89
CROIX	F	20'483	444	46.13
DEERLIJK	B	11'414	1'682	6.79
DON	F	1'359	232	5.86
EMMERIN	F	3'211	491	6.54
ENGLOS	F	562	135	4.16
ESTAIMPUIS	B	10'066	3'175	3.17
FACHES-THUMESNIL	F	17'590	462	38.07
FOREST-SUR-MARQUE	F	1'452	105	13.83
HALLENNES-LEZ-HAUBOURDIN	F	4'009	435	9.22
HALLUIN	F	20'620	1'256	16.42
HARELBEKE	B	26'957	2'914	9.25
HAUBOURDIN	F	14'367	531	27.06
HEM	F	17'988	965	18.64
HOUPLIN-ANCOISNE	F	3'447	648	5.32
HOUPLINES	F	7'712	1'132	6.81
INGELMUNSTER	B	10'728	1'616	6.64

IZEGEM	B	27'363	2'548	10.74
KORTRIJK	B	75'219	8'002	9.40
KUURNE	B	12'961	1'001	12.95
LA CHAPELLE-D'ARMENTIERES	F	8'389	1'034	8.11
LA MADELEINE	F	22'221	284	78.24
LAMBERSART	F	28'581	616	46.40
LANNOY	F	1'793	18	99.61
LEDEGEM	B	9'509	2'476	3.84
LEERS	F	9'343	540	17.30
LENDELEDE	B	5'684	1'315	4.32
LESQUIN	F	6'383	841	7.59
LEZENNES	F	3'098	214	14.48
LILLE	F	227'533	3'483	65.33
LINSELLES	F	8'181	1'171	6.99
LOMPRET	F	2'315	310	7.47
LOOS	F	20'819	695	29.96
LYS-LEZ-LANNOY	F	13'378	326	41.04
MARCQ-EN-BAROEUL	F	39'591	1'404	28.20
MARQUETTE-LEZ-LILLE	F	10'029	486	20.64
MENEN	B	32'683	3'307	9.88
MEULEBEKE	B	11'086	2'935	3.78
MONS-EN-BAROEUL	F	21'361	288	74.17
MOORSLEDE	B	10'925	3'534	3.09
MOUSCRON	B	56'011	4'008	13.98
MOUVAUX	F	13'477	417	32.32
NEUVILLE-EN-FERRAIN	F	10'266	618	16.61
OOSTROZEBEKE	B	7'556	1'662	4.55
PERENCHIES	F	8'196	303	27.05
PHALEMPIN	F	4'446	793	5.61
PREMESQUES	F	2'193	507	4.33
QUESNOY-SUR-DEULE	F	7'048	1'436	4.91
ROESELARE	B	58'823	5'979	9.84
RONCHIN	F	17'971	542	33.16
RONCQ	F	13'108	1'059	12.38
ROUBAIX	F	94'186	1'323	71.19
SAILLY-LEZ-LANNOY	F	1'752	443	3.95
SAINGHIN-EN-WEPPES	F	5'522	771	7.16
SAINT-ANDRE-LEZ-LILLE	F	11'524	316	36.47
SANTES	F	5'657	757	7.47
SECLIN	F	12'333	1'742	7.08
SEQUEDIN	F	4'356	393	11.08
TEMPLEMARS	F	3'203	461	6.95
TOUFFLERS	F	3'988	239	16.69
TOURCOING	F	92'018	1'519	60.58
TRESSIN	F	1'289	189	6.82
VENDEVILLE	F	1'653	257	6.43
VILLENEUVE-D'ASCQ	F	62'681	2'746	22.83
WAMBRECHIES	F	9'705	1'547	6.27
WAREGEM	B	36'751	4'434	8.29
WASQUEHAL	F	19'998	686	29.15
WATTIGNIES	F	13'297	631	21.07
WATTRELOS	F	41'538	1'344	30.91
WAVRIN	F	7'609	1'355	5.62
WERVICQ-SUD	F	4'870	509	9.57
WERVIK	B	18'374	4'361	4.21
WEVELGEM	B	31'076	3'876	8.02
WIELSBEKE	B	9'188	2'176	4.22
WILLEMS	F	3'030	580	5.22
ZULTE	B	15'288	3'252	4.70
ZWEVEGEM	B	24'209	6'324	3.83

Year of Reference: 2011 (F) / 2012 (B)

Source: Statbel (© Direction générale Statistique et Information économique), Recensements de la Population (INSEE)

A.2.2 Service Quantity Saturdays

Figure A 1: Spatial Distribution of Service Quantity, Basel Agglomeration (Sat)

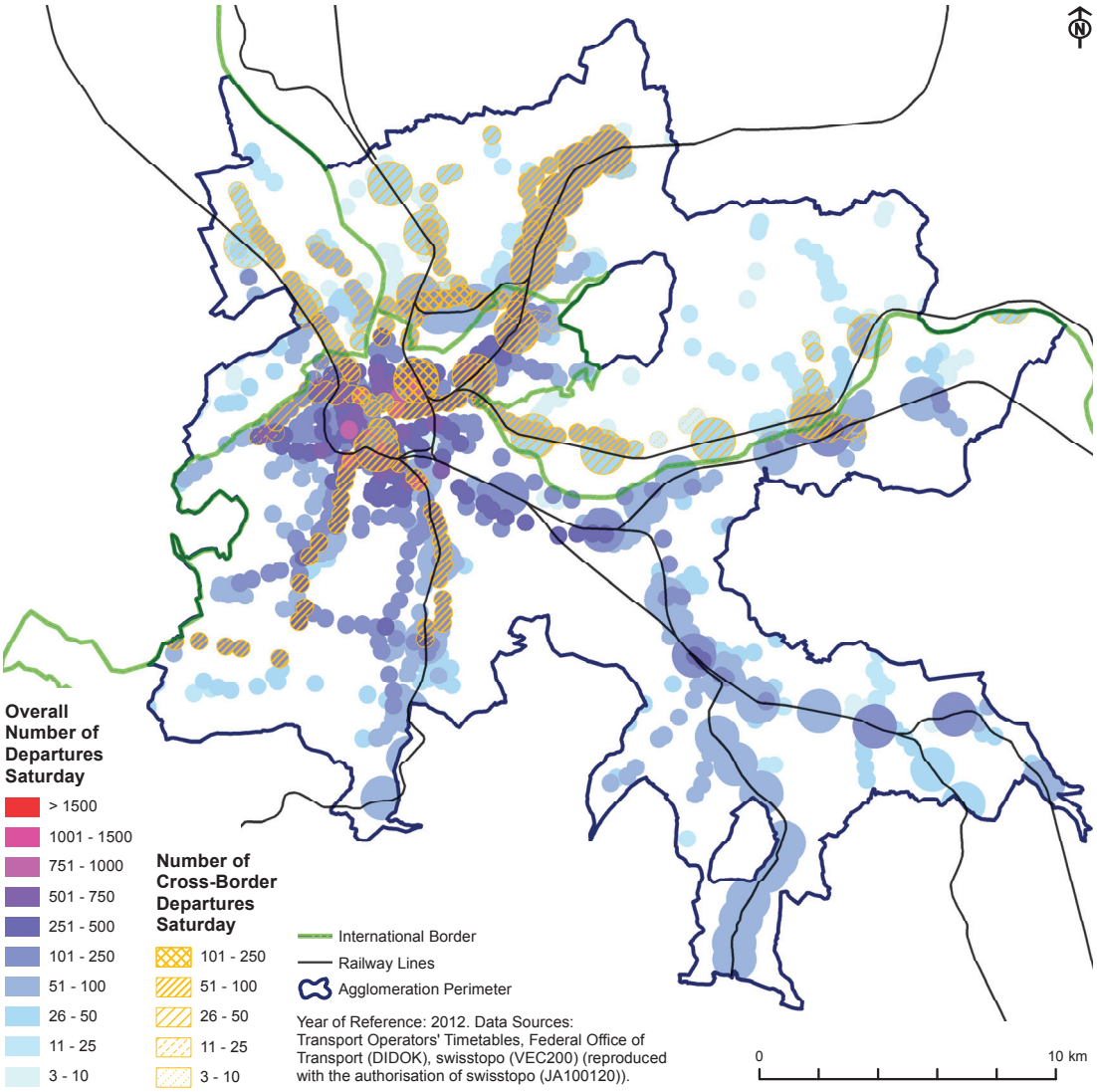
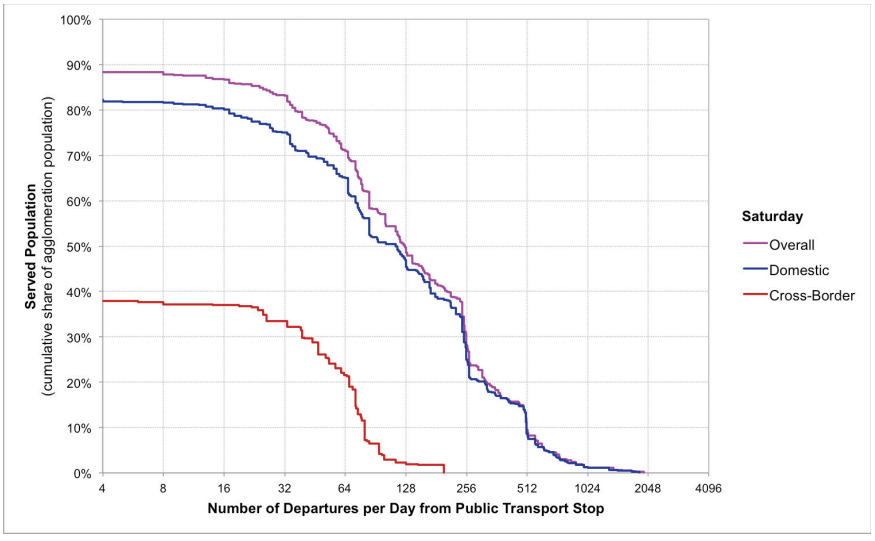


Figure A 2: Served Population by Service Quantity, Basel Agglomeration (Sat)



Share of Population [%] within Reach of Public Transport Stops

	Cross-Border Services	Domestic Services	All Services
≥ 3 departures	40	83	88
≥ 48 departures	26	69	77
≥ 128 departures	2	47	50
≥ 256 departures	0	25	28
≥ 512 departures	0	9	10

Figure A 3: Spatial Distribution of Service Quantity, Geneva Agglomeration (Sat)

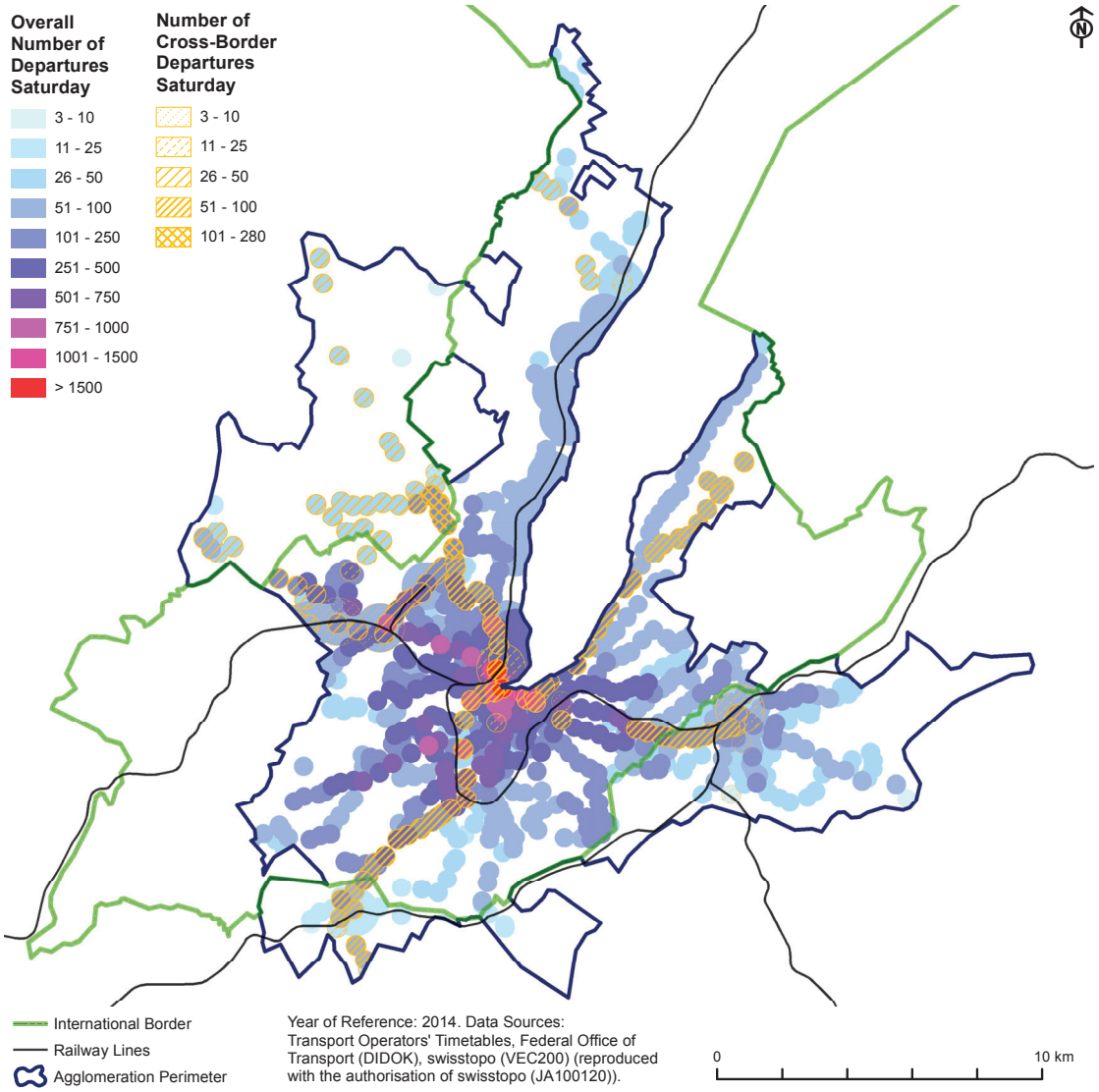
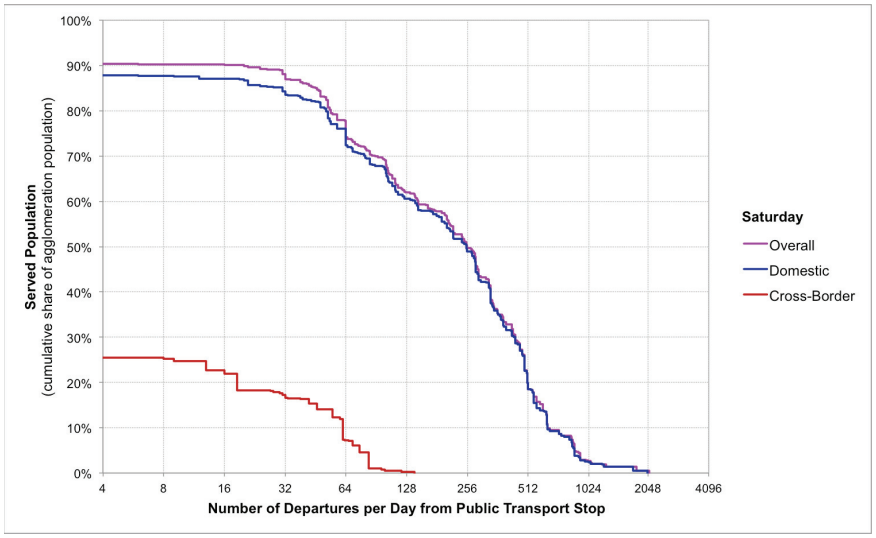


Figure A 4: Served Population by Service Quantity, Geneva Agglomeration (Sat)



Share of Population [%] within Reach of Public Transport Stops

	Cross-Border Services	Domestic Services	All Services
≥ 3 departures	25	88	90
≥ 48 departures	14	82	84
≥ 128 departures	0	61	62
≥ 256 departures	0	49	50
≥ 512 departures	0	19	19

A.2.3 Line Speed and Passenger Potential

Table A 9: Length, Journey Time and Passenger Potential per Local Bus or Tramway Line (Basel and Geneva Agglomerations)

Line Designation	Mode	Border Cross-ings	Length [km]	Journey time [min]	Commercial speed [km/h]	Source for Line Length	Passenger Potential	Passenger Potential per km
BS: BVB 1	Tramway	0	6.9	26.5	15.5	[B]	39'233	5'726
BS: BVB 2	Tramway	0	5.9	21.5	16.4	[B]	26'653	4'540
BS: BVB 3	Tramway	0	6.4	25.0	15.4	[B]	32'825	5'114
BS: BVB 6	Tramway	0	12.5	42.8	17.5	[B]	47'574	3'809
BS: BVB 8	Tramway	0	7.6	32.0	14.2	[B]	39'746	5'259
BS: BLT 10*	Tramway	0	22.1	57.0	23.3	[W]	37'175	1'681
BS: BLT 11	Tramway	0	14.2	43.8	19.5	[BL]	39'280	2'759
BS: BLT E11	Tramway	0	18.3	57.0	19.3	[W] [G]	35'025	1'915
BS: BVB 14	Tramway	0	12.6	40.3	18.7	[B]	39'091	3'108
BS: BVB 15	Tramway	0	5.4	22.5	14.3	[B]	28'185	5'267
BS: BVB 16	Tramway	0	5.4	22.0	14.6	[B]	25'086	4'677
BS: BLT 17	Tramway	0	12.2	35.5	20.6	[BL]	38'945	3'188
BS: BVB 21	Tramway	0	3.2	11.0	17.3	[B]	24'779	7'817
BS: BVB 30	Bus	0	5.8	21.0	16.6	[B]	29'675	5'107
BS: BVB 31	Bus	0	10.9	37.0	17.6	[B]	38'320	3'530
BS: BVB 32	Bus	0	6.5	20.0	19.6	[B]	7'840	1'199
BS: BVB 33	Bus	0	9.4	28.0	20.2	[B]	26'617	2'823
BS: BVB 34	Bus	0	12.8	41.5	18.6	[B]	43'023	3'350
BS: BVB 34E	Bus	0	2.5	6.0	25.0	[G]	3'530	1'412
BS: BVB 35	Bus	0	5.9	17.5	20.2	[B]	12'777	2'172
BS: BVB 36	Bus	0	15.8	52.5	18.0	[B]	71'748	4'555
BS: BLT 37	Bus	0	10.2	31.0	19.7	[BL]	18'030	1'773
BS: BVB 38	Bus	1	15.5	46.5	20.0	[B]	40'384	2'605
BS: BVB 45	Bus	0	5.6	17.0	19.7	[B]	11'846	2'121
BS: BLT 47	Bus	0	9.3	26.0	21.4	[BL]	9'838	1'062
BS: BVB 48	Bus	0	5.7	14.5	23.6	[B]	14'646	2'572
BS: BVB 50	Bus	0	8.5	17.0	29.8	[B]	10'865	1'286
BS: BVB/SWEG 55*	Bus	1	13.2	34.0	23.3	[G]	19'895	1'507
BS: BLT 58	Bus	0	7.8	18.5	25.2	[BL]	6'041	777
BS: BLT 59	Bus	0	3.7	12.5	17.9	[BL]	7'169	1'925
BS: BLT 60	Bus	0	16.7	34.5	29.0	[BL]	16'969	1'018
BS: BLT 61	Bus	0	7.4	22.0	20.3	[BL]	13'291	1'789
BS: BLT 62	Bus	0	9.2	23.0	24.0	[BL]	13'290	1'446
BS: BLT 63	Bus	0	8.9	21.0	25.5	[BL]	8'806	986
BS: BLT 64	Bus	0	17.1	47.5	21.6	[BL]	22'735	1'327
BS: BLT 65	Bus	0	5.5	14.5	22.6	[BL]	9'177	1'680
BS: BLT 66	Bus	0	5.4	17.0	19.1	[BL]	6'400	1'183
BS: Post 68	Bus	0	11.3	26.3	25.8	[G]	8'281	733
BS: AAGL 70/71*	Bus	0	5.7	12.0	28.5	[G]	5'344	938
BS: AAGL 72*	Bus	0	6.1	14.5	25.2	[G]	4'670	766
BS: AAGL 75	Bus	0	2.0	7.0	17.1	[A]	4'450	2'225
BS: AAGL 76	Bus	0	4.3	11.5	22.4	[A]	5'327	1'239
BS: AAGL 78	Bus	0	9.9	42.0	14.1	[A]	11'227	1'134
BS: AAGL 80	Bus	0	18.1	45.0	24.1	[A]	18'841	1'041
BS: AAGL 81	Bus	0	17.9	32.0	33.6	[A]	13'759	769
BS: AAGL 82	Bus	0	2.0	4.0	30.0	[A]	1'167	584
BS: AAGL 83*	Bus	0	10.4	34.0	18.4	[G]	18'117	1'742
BS: Post 84	Bus	0	6.2	16.5	22.5	[G]	8'635	1'393
BS: Post 85	Bus	0	2.2	5.0	26.4	[G]	4'098	1'863
BS: Post 86	Bus	0	3.9	14.0	16.7	[G]	5'567	1'427
BS: Post 88	Bus	0	6.8	21.0	19.4	[G]	9'725	1'430
BS: SWEG 1/2*	Bus	0	8.0	16.5	29.1	[G]	9'276	1'160
BS: SWEG 3*	Bus	1	4.0	13.5	17.8	[G]	13'833	3'458
BS: SWEG 6	Bus	0	7.8	27.0	17.3	[G]	37'671	4'830
BS: SWEG 16	Bus	2	16.3	58.5	16.7	[G]	40'315	2'473

BS: SWEG 7	Bus	0	5.7	24.5	14.0	[G]	14'807	2'598
BS: SWEG 8	Bus	0	7.6	25.5	17.9	[G]	17'544	2'308
BS: SWEG 12	Bus	0	7.6	27.8	16.4	[G]	16'810	2'212
BS: SWEG 15*	Bus	0	15.6	35.5	26.4	[G]	15'871	1'017
BS: SWEG 66	Bus	0	9.6	25.0	23.0	[G]	7'405	771
BS: SBG 7301*	Bus	1	21.6	53.0	24.5	[G]	31'901	1'477
BS: SBG 7302*	Bus	0	8.0	23.5	20.4	[G]	11'561	1'445
BS: SBG 7304	Bus	0	15.3	29.0	31.7	[G]	14'059	919
BS: SBG 7307*	Bus	0	9.0	19.5	27.7	[G]	10'319	1'147
BS: SBG 7311	Bus	0	8.0	22.0	21.8	[G]	6'472	809
BS: SBG 7312	Bus	1	7.2	29.0	14.8	[G]	19'227	2'689
BS: Distribus 1*	Bus	0	5.4	19.5	16.6	[G]	12'172	2'254
BS: Distribus 2*	Bus	0	7.2	25.3	17.1	[G]	10'897	1'513
BS: Distribus 3	Bus	1	8.8	24.3	21.8	[D] [G]	15'614	1'770
BS: Distribus 4	Bus	1	9.4	27.0	20.9	[D] [G]	18'844	2'005
BS: Distribus 6*	Bus	0	9.1	20.0	27.2	[D] [G]	8'457	934
BS: Distribus 7*	Bus	1	4.3	15.0	17.2	[G]	14'039	3'265
BS: Distribus 9	Bus	0	5.4	18.5	17.5	[D] [G]	3'307	611
BS: Distribus 10	Bus	0	3.1	10.0	18.5	[D] [G]	2'036	661
BS: Distribus 11	Bus	0	3.6	10.0	21.3	[D] [G]	2'036	574
GE: TPG 1	Bus	0	9.5	47.8	11.9	[T]	74'915	7'919
GE: TPG 2	Bus	0	8.4	33.5	15.0	[T]	44'456	5'324
GE: TPG 3	Bus	0	7.8	35.0	13.3	[T]	59'662	7'688
GE: TPG 4	Bus	0	8.6	28.5	18.1	[T]	21'885	2'551
GE: TPG 5	Bus	0	11.2	47.8	14.0	[T]	49'108	4'404
GE: TPG 6	Bus	0	8.9	36.0	14.8	[T]	53'889	6'062
GE: TPG 7	Bus	0	6.9	30.3	13.6	[T]	42'232	6'147
GE: TPG 8	Bus	0	11.2	42.3	15.9	[T]	44'218	3'941
GE: TPG 9	Bus	0	11.1	43.5	15.4	[T]	63'015	5'657
GE: TPG 10	Bus	0	6.5	29.5	13.1	[T]	44'226	6'846
GE: TPG 11	Bus	0	8.7	37.8	13.9	[T]	58'269	6'682
GE: TPG 12	Tramway	0	9.3	40.3	13.9	[T]	68'199	7'325
GE: TPG 14	Tramway	0	11.3	42.3	16.1	[T]	66'636	5'876
GE: TPG 15	Tramway	0	6.8	29.0	14.1	[T]	47'615	7'002
GE: TPG 18	Tramway	0	8.3	27.3	18.2	[G]	42'577	5'161
GE: TPG 19	Bus	0	11.8	45.8	15.4	[T]	68'912	5'860
GE: TPG 21	Bus	0	11.9	46.8	15.2	[T]	53'116	4'482
GE: TPG 22	Bus	0	10.8	36.0	18.1	[T]	41'636	3'845
GE: TPG 23	Bus	0	12.3	38.5	19.1	[T]	29'926	2'439
GE: TPG 25	Bus	0	8.1	33.5	14.5	[G]	42'478	5'244
GE: TPG 27	Bus	0	3.9	20.0	11.7	[G]	32'206	8'258
GE: TPG 28	Bus	0	11.9	37.0	19.3	[T]	14'434	1'215
GE: TPG 31	Bus	0	6.0	20.8	17.4	[T]	13'262	2'203
GE: TPG 32	Bus	0	1.4	13.8	5.9	[T]	19'975	14'796
GE: TPG 33*	Bus	0	6.1	20.0	18.2	[T] [G]	19'623	3'227
GE: TPG 34*	Bus	0	9.9	28.0	21.3	[T] [G]	11'988	1'208
GE: TPG 35	Bus	0	1.9	17.0	6.6	[T]	19'317	10'275
GE: TPG 36	Bus	0	1.6	15.0	6.4	[T]	10'977	6'818
GE: TPG 41	Bus	0	8.4	24.8	20.5	[T]	11'957	1'417
GE: TPG 42	Bus	0	11.9	42.8	16.7	[T]	27'377	2'303
GE: TPG 43	Bus	0	8.0	23.5	20.4	[T]	9'162	1'148
GE: TPG 44	Bus	0	4.9	13.5	21.7	[T]	8'940	1'832
GE: TPG 45	Bus	0	3.7	13.8	16.0	[T]	8'580	2'338
GE: TPG 46	Bus	0	6.7	20.3	19.7	[T] [G]	8'351	1'254
GE: TPG 47	Bus	0	1.9	6.0	19.2	[T] [G]	5'920	3'083
GE: TPG 51	Bus	0	7.9	28.0	16.9	[T]	25'445	3'221
GE: TPG 53	Bus	0	4.2	13.0	19.5	[T]	14'118	3'338
GE: TPG 54*	Bus	0	2.0	5.5	21.8	[G]	3'872	1'936
GE: TPG 57*	Bus	0	8.7	29.0	18.0	[T] [G]	21'057	2'420
GE: TPG 61	Bus	1	9.2	37.8	14.6	[G]	33'804	3'674
GE: TPG A*	Bus	0	6.9	20.5	20.2	[T]	18'562	2'690
GE: TPG B	Bus	0	7.7	14.5	32.0	[T]	5'240	678
GE: TPG C*	Bus	0	6.3	20.5	18.4	[G]	15'602	2'477
GE: TPG D	Bus	1	10.1	33.3	18.2	[G]	27'111	2'684
GE: TPG Dn*	Bus	0	2.8	10.3	16.4	[G]	6'257	2'235
GE: TPG E	Bus	0	13.5	33.3	24.3	[T]	19'879	1'474

GE: TPG F*	Bus	1	11.2	42.3	16.0	[T]	22'703	2'020
GE: TPG G*	Bus	0	9.0	27.0	20.1	[T]	16'065	1'777
GE: TPG K*	Bus	0	5.8	18.5	18.8	[G]	16'176	2'789
GE: TPG L*	Bus	0	9.1	23.8	23.0	[G]	16'622	1'827
GE: TPG M*	Bus	0	3.0	10.5	17.1	[G]	3'904	1'301
GE: TPG O	Bus	1	9.2	23.0	24.1	[T]	10'138	1'098
GE: TPG S*	Bus	0	6.9	16.5	25.1	[T] [G]	7'162	1'038
GE: TPG V	Bus	0	15.6	45.8	20.5	[T]	25'643	1'643
GE: TPG Y*	Bus	1	17.2	48.0	21.5	[T] [G]	11'642	676
GE: TPG Z*	Bus	0	5.5	20.8	15.9	[T] [G]	13'682	2'488
GE: TAC 1	Bus	0	5.7	25.5	13.3	[G]	23'639	4'184
GE: TAC 2	Bus	0	10.1	42.0	14.4	[G]	27'985	2'785
GE: TAC 3	Bus	0	13.7	51.5	16.0	[G]	40'191	2'934
GE: TAC 4*	Bus	0	14.4	43.0	20.1	[G]	28'647	1'989
GE: TAC 5*	Bus	0	14.2	43.0	19.8	[G]	21'986	1'548
GE: TAC 6	Bus	0	8.5	29.5	17.2	[G]	17'931	2'122
GE: Cars-RA 33*	Bus	0	18.1	34.0	31.9	[G]	4'676	258
GE: LIHSA 11	Bus	0	15.7	32.0	29.4	[G]	11'159	1'019
GE: LIHSA 12*	Bus	0	3.9	16.5	14.2	[G]	15'442	813
GE: LIHSA 102*	Bus	0	9.0	24.3	22.1	[G]	13'572	963
GE: LIHSA T71*	Bus	1	11.0	22.0	29.9	[G]	10'976	699
GE: LIHSA T72*	Bus	1	19.0	60.0	19.0	[G]	6'667	1'709
GE: LIHSA T73*	Bus	1	14.1	36.0	23.5	[G]	11'186	1'250
GE: TPN 811*	Bus	0	2.3	8.5	15.9	[G]	2'526	1'123
GE: TPN 813*	Bus	0	9.8	28.5	20.6	[G]	5'357	547
GE: TPN 814*	Bus	0	4.8	12.0	24.0	[G]	1'721	359

BS = Basel Agglomeration; GE = Geneva Agglomeration; [A] = 2012 Annual Report Autobus AG Liestal; [B] = 2012 Annual Report Basler Verkehrsbetriebe; [BL] = 2012 Annual Report Baselland Transport AG; [D] Distribus data; [G] = GoogleMaps (average of both directions); [T] = 2012 Annual Report transports publics genevois; [W] = Wägli (2010).

* Line extending beyond agglomeration perimeter. Here, only the section until the last stop within the perimeter and only residents within the perimeter have been considered.

Year of Reference: Basel: 2012; Geneva: 2014.

Sources of journey time, commercial speed and passenger potential, as well as assumptions and methodology, see chapter 4.2: elements (d), (h), [c], [d] [f], E (pp. 60-63)

A.3 Curriculum Vitae

Emanuel Barth

Born 11 March 1984 in Basel (Switzerland)

Citizen of Basel

Practical Experience

2008–2014

Research assistant at ETH Zurich, Institute for Transport Planning and Systems (IVT), Chair of Transport Systems

2008

Internship at Rapp Trans AG, transport consultancy, Basel

2006

Internship at the Cantonal Office for Building and Planning, Basel

2003–2004

Internships at the University of Basel, Institute of Geography

Education

2008–2014

PhD student at ETH Zurich, Department of Civil, Environmental and Geomatic Engineering

2006–2007

MSc (Distiction) in Transport and Planning, Cardiff University (UK), School of City and Regional Planning

2003–2006

BSc in Geosciences (Major in Geography), University of Basel

2002

Matura (Ancient Greek and Latin), Gymnasium am Münsterplatz, Basel