International Transport Forum

Income Inequality, Social Inclusion and Mobility

Roundtable Report

OECD

Income Inequality, Social Inclusion and Mobility

Roundtable report

The International Transport Forum

The International Transport Forum is an intergovernmental organisation with 57 member countries. It acts as a think tank for transport policy and organises the Annual Summit of transport ministers. ITF is the only global body that covers all transport modes. The ITF is politically autonomous and administratively integrated with the OECD.

The ITF works for transport policies that improve peoples' lives. Our mission is to foster a deeper understanding of the role of transport in economic growth, environmental sustainability and social inclusion and to raise the public profile of transport policy.

The ITF organises global dialogue for better transport. We act as a platform for discussion and pre-negotiation of policy issues across all transport modes. We analyse trends, share knowledge and promote exchange among transport decision-makers and civil society. The ITF's Annual Summit is the world's largest gathering of transport ministers and the leading global platform for dialogue on transport policy.

The Members of the ITF are: Albania, Armenia, Argentina, Australia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Canada, Chile, China (People's Republic of), Croatia, Czech Republic, Denmark, Estonia, Finland, France, Former Yugoslav Republic of Macedonia, Georgia, Germany, Greece, Hungary, Iceland, India, Ireland, Israel, Italy, Japan, Korea, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Mexico, Republic of Moldova, Montenegro, Morocco, the Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Serbia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, the United Kingdom and the United States.

International Transport Forum
2, rue André Pascal
F-75775 Paris Cedex 16
contact@itf-oecd.org
www.itf-oecd.org

ITF Roundtable Reports

Table of contents

Figures

Tables

Boxes

Executive summary

What we did

There is significant evidence across countries that lower-income populations tend to suffer more from restricted transport options, have lower quality transport services available to them and travel under worse conditions (safety, security, reliability, comfort). Broad evidence also suggests that the lack of, or poor access to, transport options is central to limitations on access to jobs, educational institutions, health facilities, social networks, etc., which in turn generates a "poverty trap".

The ITF Roundtable Report "Income Inequality, Social Inclusion and Mobility" examines mobility policies with a focus on evaluating their capacity to address transport-related exclusion of lower income groups. The document was prepared by the ITF Secretariat following an event that brought together a number of international experts, academics and policy makers, and includes input papers developed for the event and a synthesis of the debate, developed to embed conclusions in the relevant research literature. This work is part of the OECD's Centre for Opportunity and Equality, which is a platform initiated in 2015 for promoting and conducting policy-oriented research on the trends, causes and consequences of inequalities.

What we found

Despite cross-country and cross-city differences, the following priorities were identified as universal for advancing the inclusive transport agenda. These include a) developing policies that are driven by improved data and analysis; b) co-ordinating housing and transport policies because of their indissociable relationship and their central role in peoples' livelihood; and c) setting coherent pricing policies for each transport mode that support both sustainable mobility and social inclusion goals. In line with these overarching principles, the following actions are recognised as necessary.

What we recommend

Improving data and developing effective performance indicators

Authorities need to develop better performance indicators for quantifying and better understanding the nature of exclusion. Multimodal location-based accessibility indices and housing plus transport affordability indices have proven to be valuable tools. They improve understanding of transport poverty and its effects on social exclusion spatially and across population segments. They also have important potential for enabling land use, housing and transport authorities to set common goals and co-ordinate planning. While various programmes have started incorporating such indicators, going beyond occasional use to their systematic inclusion in transport, housing and land use policy frameworks will be vital.

Rethinking housing policies

Housing, urban development and transport authorities need to assess decisions with a comprehensive view of the impact of location, housing quality and transport options on livelihoods. Incorporating transport-related indicators (travel times and costs), particularly for reaching jobs, into housing quality definitions used in the design and evaluation of social and affordable housing programmes is particularly important.

Readjusting urban renewal and transit-oriented development strategies

Urban renewal strategies need to shift away from clearing slums to a strong focus on seizing opportunities for rehabilitation, and offering the population the opportunity to choose between their present and alternative locations. Where TOD principles are central to urban renewal, these principles need to be adapted to the size, mobility characteristics and purchasing power of residents, especially low income residents.

In particular, city planners should acknowledge how informal settlements have naturally yielded TOD characteristics adapted to the wants and needs of lower income residents. They also need to acknowledge that, while TOD principles can make urban renewal more inclusive - notably by focusing on improving public transport and non-motorised mobility - the effect of increasing land and property values displaces the poor even where eviction is not part of the urban renewal strategy. To address this, it is essential to design and measure the performance of TOD projects in terms of equity and social inclusion.

Mobilising increases in land value to deliver objectives for social inclusion

Methods of financing that incorporate land value capture mechanisms have demonstrated significant potential for reducing the social inclusion challenge of TOD and urban renewal. But authorities need to ensure that land value capture mechanisms channel part of future increases in the value of property directly to meeting policy objectives, including social inclusion goals. Where this is not the case, the measures could, on the contrary, accelerate the displacement of low-income populations.

Making public transport subsidies efficient and financially sustainable

Given competing needs for public funds and the limited resources, public transport subsidy schemes need to put as little strain as possible on public finances. They need to ensure efficient resource allocation and make sure subsidies are effectively translated into livelihood improvements (which go beyond travel time savings). Targeted subsidies, as opposed to generalised support, are a better way of striking a balance between financial sustainability and service affordability. An increasing number of cities are building on the adoption of new technology, including smart cards, to put targeted subsidy schemes into effect.

Participants also identified core issues for future discussion:

- Understanding the role, potential and limitations of shared vehicles for contributing to the reduction of social exclusion – in particular, analysing whether gains in productivity from this vehicle sharing through technology would allow provision of affordable services for lower income residents, or if subsidies would still be needed.
- Correcting policy biases and market distortions that favour car travel over more affordable modes.
- Attracting investment to programmes for the reduction of transport-related exclusion – in particular, exploring ways to a) improve and complement appraisal tools; b) calculate and add co-benefits to financial assessments; and c) shift financial and institutional resources from silo-structured to multi-sector programmes and projects.

Chapter 1
Income inequality, social inclusion and mobility

Aimée Aguilar Jaber
Economist, International Transport Forum

Especially in the present context of increasing levels of inequality, analyzing mobility policies with a focus on evaluating their capacity to address transport-related social exclusion is of particular importance. This chapter builds on discussions held during a Roundtable meeting that was dedicated to this objective and brings forward key findings and conclusions reached. A first section is dedicated to describing in detail the scope of discussions and identifies universal principles for advancing the inclusive transport agenda. The chapter then looks at data limitations that impede accurate analysis of transport related exclusion, followed by detailed analysis on three policy issues: rethinking housing policy, urban renewal and transit-oriented development; making public transport subsidies efficient and financially sustainable; and improving clarity on socio-economic issues related to transport demand management policies. The closing section highlights priorities identified for future research.

Introduction

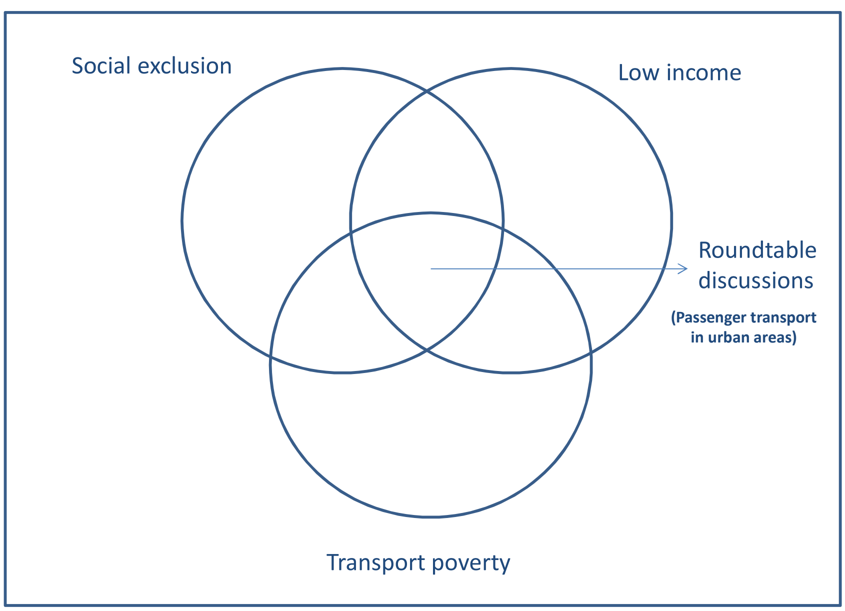
Governments across ITF member countries are concerned about increasing levels of inequality, even as average per capita incomes rise, because of the social exclusion that results. This is reflected in the creation in 2015 of the OECD Centre for Opportunity and Equality, which is a platform for promoting and conducting policy-oriented research on the trends, causes and consequences of inequalities. The Income Inequality, Social Inclusion and Mobility Roundtable was organised as part of this initiative.

Scope

Not all the socially excluded are poor and not all social exclusion is linked to limited access to transport. However, there is significant evidence across countries that a) lower income people tend to suffer more from restricted transport options, have lower quality transport services available to them and travel under worse conditions (safety, security, reliability, comfort), and b) poor or non-existent access to transport options is central to restrictions on access to jobs, education and health facilities, social networks, etc., which in turn generates a "poverty trap" (Lucas et al., forthcoming).

Discussions during the roundtable were dedicated to analysing mobility policies in the light of this phenomenon, i.e. with a focus on evaluating their capacity to address transport-related exclusion of lower income groups. Figure 1.1 describes visually the scope of discussions.

Figure 1.1. **Scope of discussions**



Definitions for social exclusion and transport poverty, as understood in the context of this report, are as follows:

Social exclusion (Kenyon et al., 2002):

[T]he unique interplay of a number of factors, whose consequence is the denial of access, to the opportunity to participate in the social, and political life of the community, resulting not only in diminished material and non-material quality of life, but also in tempered life chances, choices and reduced citizenship.

Transport poverty (Lucas et al., 2016):

An individual is transport poor if, in order to satisfy their daily basic activity needs, at least one of the following conditions apply:

- There is literally no transport option available that is suited to the individual's physical condition and capabilities.
- The existing transport options do not reach destinations where the individual can fulfil his/her daily activity needs, in order to maintain a reasonable quality of life.
- The necessar[y] ... amount spent on transport leaves the household with a [low] residual income ... .
- The individual needs to spend an excessive amount of time travelling, leading to time poverty or social isolation.
- The prevailing travel conditions are dangerous, unsafe or unhealthy for the individual.

This definition of social exclusion was selected as sufficiently flexible to apply to conditions in the broad range of countries and contexts analysed. Nevertheless, it was also found to reflect the key points of convergence highlighted during the discussions:

- recognising that a multiplicity of factors needs to be considered when analysing social exclusion
- acknowledging the relevance of choice, or lack of choice, as central to identifying the socially excluded
- considering not only lack of access but also its incidence on life quality and opportunities as fundamental to the problem of social exclusion.

Transport poverty is the term chosen to describe poor or non-existent access to transport options. The concept is used as developed in Lucas et al. (2016), where it incorporates multiple dimensions of transport-related limitations faced by individuals (all considered relevant during the discussions): lack of affordability, non-existent or poor transport services (in particular motorised modes), difficulty in reaching necessary and desired activities through available modes of transport, and disproportionate exposure to negative transport externalities. Consideration of transport poverty from an affordability perspective has been slightly modified, as the approaches for determining affordability reviewed during the roundtable explore thresholds that differ from the criteria used in the original work, i.e. residual income after transport expenses that is below the official poverty line.

Finally, discussions were focused on the movement of people and on analysis of urban areas.

The rest of this chapter is organised in three sections. The first looks at data limitations that impede accurate analysis of the nature and scale of transport-related exclusion. It also evaluates the potential of location-based accessibility indices and housing plus transport affordability indices for understanding the issues and improving policy. The second section focuses on three policy issues identified as priorities for deeper examination: a) rethinking housing policy, urban renewal and transit-oriented development; b) making public transport subsidies efficient and financially sustainable; and c) improving clarity on socio-economic issues linked to transport demand management policies. The final section discusses conclusions and outlines priorities identified for future research.

Debate at the roundtable highlighted the relevance of analysing cross-country and cross-city differences and adapting policies to the different contexts. Certain priorities, however, were identified as universal for advancing the inclusive transport agenda: a) the need to develop policies that are driven by improved data and analysis, b) the urgency of co-ordinating policies between housing and transport and c) the need for coherent pricing policies for each mode of transport, in line with sustainable mobility and social inclusion goals. Thus these are overarching elements present throughout the chapter.

Improving data and developing useful performance indicators

Surveys are central to conducting equity-related analysis of mobility trends and policies. Among the most widely used are censuses, income-expenditure surveys, origin-destination surveys (also called household travel surveys) and surveys characterising socio-economic conditions of the population. The data and the basic indicators calculated based on these surveys also constitute the building blocks of more complex tools being developed with the aim of improving understanding of transport-related exclusion, including those analysed later in this section. Enhancing the data available from these sources is a priority. The following improvements were identified as necessary:

- *Accounting for income transfers and savings when breaking down population by income levels.* Conducting analysis based on statistics that fail to exclude non-poor population groups from the lowest income categories produces misleading conclusions. It hides or minimises, for example, the disproportionately higher travel times and distances travelled by the truly poor, since these are averaged with those of residents who can afford to live closer to their place of work and/or have access to faster modes of transport. It can also greatly overestimate the proportion of car ownership among lower income residents. In particular, it is necessary to make sure retirees and students who have savings or receive allowances from parents, and thus are not in poverty, are not included in the lowest income categories.
- *Producing data and indicators that permit analysis at the right scale and are sufficiently updated.* Adequate analysis is also hindered either because surveys are only representative at national level or because the breakdown at local level does not coincide with functional urban areas, leaving many peripheries unaccounted for.[1] Since peripheral areas often concentrate high proportions of lower income residents, who have the fewest and/or more costly (in terms of money and time) transport services available, this leads to significant underestimates of the transport-related burden in many urban areas. In particular, origin-destination surveys in many cities are not conducted often enough and also tend to be limited spatially to core cities instead of metropolitan areas. Overall, survey design making it possible to come up with indicators for functional urban areas, and to compare regions within them (e.g. core city vs peripheries, or areas that are clearly divided in terms of socio-economic conditions) will significantly improve analysis.
- *Separating transport expenses from impractical data groupings and re-examining expenditures included in this category.* The possibility of conducting detailed analysis of household transport expenses is limited in many countries because transport and other type of expenditures, such as telecommunications, are grouped together. Even where this is not the case, the transport-related expenses included do not always cover all modes and fail to include items relevant to households (e.g. parking – especially parking at home – or purchase of bicycles used for travel). Solving these two problems will significantly increase the scope and depth of analysis that can be conducted with information from income-expenditure surveys.
- *Controlling average expenses by the proportion of population incurring them.* Making averages of various transport expenditures based on total population rather than the share of the population actually making them is also a common cause of misleading results. In the case of lower income groups, averaging, for instance, vehicle ownership costs using total

population rather than only car owners can considerably minimise the shares of income spent on fuel, maintenance, etc., by those lower income residents who may be "captive" car users.

- *Identifying spending decisions that result from the lack of transport alternatives.* Analysis based on income-expenditure surveys tends to ignore the fact that households may be spending too much or too little on transport due to restricted options. For example, households located where there are limited public transport services spend high shares of their income on car purchase and maintenance. Or lack of affordable services may result in poor households reducing the number of motorised trips they make. Efforts to collect complementary data for recognising these groups is particularly important in designing policies aimed at reducing transport-related social exclusion.

While traditional surveys are valuable sources of information, they are costly for authorities and time consuming for residents. Introducing technology-based procedures is important for reducing the monetary and time costs of collecting, processing, and analysing data gathered through these tools. Authorities should increasingly look into the potential of big data sources for improving data quality and level of detail while bringing down costs. They could complement and in some cases replace surveys. Making sure that data, related indicators and analysis meet the conditions listed above will, however, remain necessary even if information comes from sources other than traditional surveys.

Furthermore, authorities need better performance indicators for quantifying and understanding the nature of exclusion. Indicators need to be useful for determining whether policy interventions have been successful. They also need to facilitate moving away from segmented analysis that impedes understanding of how policies interact in different sectors (particularly between land use and transport policies) and their ultimate effect on livelihoods. A number of indices have been developed as part of the effort to improve indicators. Each addresses particular dimensions of transport poverty and social exclusion, as well as factors behind them. Discussions during the roundtable included in-depth analysis of two types of indicators: location-based accessibility indices and housing plus transport affordability indices. Insight about their value, limitations, challenges and potential to improve policies was generated.

Location-based accessibility indices

While simple to construct, performance indicators based on traffic (vehicle movement) and mobility (movement of people) have significant limitations. By narrowing down the problem to maximising physical movement, both fail to provide accurate information about changes in access to goods, services, activities and destinations. In particular, they overlook the importance of non-motorised modes, location-efficient urban development patterns, and mobility substitutes (e.g. home office, delivery services), all of which improve accessibility while reducing overall distance and travel. In the case of traffic-based indicators, public transport is also given little value as it represents fewer vehicle-kilometres than private vehicles. In sum, a significant mismatch exists between policy design and projects focusing on increasing traffic and/or mobility and enhancing accessibility (Litman, 2011).

Accordingly, indicators directly measuring accessibility – or the opportunity of individuals and groups of individuals to participate in activities – have proved more useful for designing and evaluating policies. However, accessibility is more difficult to measure than mobility or traffic because it depends on:

- land-use factors: the amount, quality and spatial distribution of opportunities, demand for these and competition for activities generated by the interaction of supply and demand in a given place

- transport factors: time, effort and monetary resources required to cover the desired origin-destination distance with the existing transport infrastructure and services
- temporal factors: changes in availability of opportunities depending on time of day
- characteristics of individuals.

A range of approaches have been developed; within these, some location-based indicators focus on analysing accessibility to activities offered by different locations (Geurs and Ristema van Eck, 2001).

Contour accessibility indicators

Simpler indicators of this type (called contour or isochronic indices) focus on a) calculating the number of opportunities or facilities (e.g. transport stations) which can be reached within a given travel time, distance or cost, or b) measuring the time/cost (average or total) required to gain access to a fixed number of opportunities from different locations (Geurs and Ristema van Eck, 2001). Work conducted by the World Bank using such indices highlights their value for examining urban growth patterns and their effect on employment accessibility of different populations. The methodology developed was recently used to assess the case of Greater Buenos Aires (GBA), in Argentina.

The analysis focuses on employment opportunities and accessibility is defined as the number of job opportunities that can be reached within 60 minutes of travel. Mode-specific accessibility indices are calculated for car and public transport. In addition, a ratio of the two indices is calculated, providing information on the number of jobs that can be accessed by car in relation to every option available when using public transport (given the same 60 minute commuting threshold). The three indices (car accessibility, public transport accessibility and ratio of car to public transport accessibility) are shown in heat maps, which allow identifying spatial accessibility inequalities across GBA.[2] A combination of open data sources is used to get information on the road network and public transport characteristics, which, together with information from the city's mobility survey, allow estimates of average travel times for every origin-destination pair, and the accessible employment opportunities provided by each mode in different areas of the city (using the Open Trip Planner Analyst engine) (Peralta Quiroz and Shomik, 2014).[3]

Combining information on accessibility with urban growth patterns, identified by analysing remote sensing data, makes it possible to see that urban growth in GBA has generally happened in areas where overall accessibility is poor and public transport accessibility even worse. Two underlying phenomena highlight the links between income, spatial and employment accessibility inequalities in GBA: the significant development of gated communities of higher income residents (car owners) in areas where only car accessibility is being developed (mostly in the northern corridor) and the fact that, despite high reliance of lower income groups on public transport, which accounts for 45% of total travel stages for residents in the lowest income quintile, social housing is not located where public transport employment accessibility is high. Some informal settlements have also developed, mostly in areas with poor public transport employment accessibility (Peralta Quiroz and Shomik, 2014).

The analysis can be taken a step further by combining information on accessibility and density, identifying areas that have potential for densification and already offer good employment accessibility by public transport. This type of analysis was carried out for GBA using the accessibility ratio (car/public transport accessibility) and an indicator that calculates the percentage of job opportunities accessible through public transport relative to the most accessible area of the city. If linked to the urban planning framework, the results could bring significant improvement by providing a solid tool for linking investment to development in areas identified as offering opportunities for efficient development. Moreover, once the larger areas for potential efficient development are identified, the same analysis can be carried out using more granular accessibility indices. Authorities, in co-operation with developers, could thus identify problems and design solutions for specific cases (e.g. particular gated communities, isolated social housing developments).

Overall, contour accessibility indicators provide an opportunity to significantly improve analysis for cities that are not data rich. Methodologies such as that described above show that the indicators can be constructed by taking advantage of new open data sources and combining them with data from existing mobility surveys. Other new data sources (e.g. remote sensing) provide the possibility of adding analysis on urban growth patterns, which, together with these indicators, can a) provide improved vision on how the distribution of opportunities (resulting from land use policy) and the availability of transport services (resulting from transport policy) play out in generating inequalities in these cities; and b) constitute a basic but solid tool for introducing accessibility as an explicit parameter to be taken into account in urban development decisions.

Contour indices have also been useful for cities that, although relatively data rich, benefit from the fact that the indices are fairly simple to calculate and update and easy to communicate and operationalise. An example is London, which has made them a central component of its planning framework and has set up a publicly available tool enabling developers to calculate the indices for specific projects. The best known of the indicators used by Transport for London (TfL), is the Public Transport Accessibility Level (PTAL), measuring accessibility to the public transport network across Greater London. The score provides information on how close a selected point in the city is to public transport and how frequent services are in that place. Calculation of the index takes into account the walking time to all public transport service access points (SAPs) within a given distance threshold.[4] This is combined with the average time a user has to wait in the SAP for the next service. The sum of the waiting and walking time for all routes available from a given location is converted to levels of frequency. To calculate the final access index (AI), routes available by each mode of public transport are compared, assigning a weight of 1 to the one presenting the highest overall frequency score and weighting all others by 0.5 (TfL, 2015). The final AI is the sum of the access indices of all available public transport modes, which is transformed into a PTAL on a scale from 1 to 6 (TfL, 2010).[5]

PTALs are used in the London Plan as an essential tool for determining suitable density of development across Greater London. The London Plan also uses them for calculating recommended parking capacity in housing and commercial developments, under the principle that higher PTAL areas (those better connected to the public transport network) need fewer parking spaces. A third use for PTALs is to monitor the share of business and commercial activities taking place in areas that have good connections to the public transport network (i.e. that have a PTAL of 5 or above). This is used to verify compliance with the goal set in the London Plan of having a high share of workplaces that are well connected to public transport.

The PTAL is also used as part of the transport assessment required for specific development projects, evaluating the impact certain changes to the network could have in increasing accessibility to public transport in a selected area. It is used to make the development of an area conditional upon providing a sufficient level of public transport and offers the evidence base for negotiations with private developers on their contribution to infrastructure funding. A good example of this is the analysis conducted for redevelopment of the Vauxhall, Nine Elms and Battersea (VNEB) Opportunity Area (OA) (Box 1.1). TfL's Web-based Connectivity Assessment Toolkit (WebCAT) allows users to create their own PTAL maps and view PTALs for future development scenarios.

Box 1.1. **PTAL assessment and the redevelopment of Vauxhall, Nine Elms and Battersea**

The VNEB OA is located in the boroughs of Wandsworth and Lambeth on the south bank of the River Thames; its northern edges are a kilometre south of the Houses of Parliament and Victoria Station. At 227 hectares it is the largest remaining OA in London's economic and cultural core, the Central Activities Zone, which is the city's most attractive and competitive business area (GLA, 2015).

The London Plan requires high density development with high trip generation patterns to be met by a high level of access to public transport and enough transport capacity to absorb the impact of development. Accordingly, a detailed transport assessment was carried out as part of the VNEB OA Planning Framework. The study, in consultation with key stakeholders, included travel demand forecasting and public transport modelling for various development scenarios and assessed to what extent already planned transport interventions by TfL would support the development objectives of the OA. Based on the preferred development scenario for the area, which includes high density housing and major retail development, the assessment suggested a comprehensive package of measures aimed at increasing transport capacity and accessibility and bring about the change in public transport accessibility required to make it an attractive area. Improving pedestrian, cycling and public transport provision in the area is central to this strategy. The main components of the strategy, to be complemented by a set of more local transport improvements, are:

- extending the Northern Line of the Underground, connecting new stations at Battersea and Nine Elms with Kennington in the north-east part of the OA
- increasing the capacity of existing bus routes and stops serving the OA and creating new ones
- improving walking and cycling, notably through a new pedestrian and cycle bridge connecting Nine Elms with Pimlico across the river.

The PTAL was part of the transport assessment and was used in negotiations with developers on their contributions to funding for the Northern Line extension, which, together with improvement to walking routes around the Battersea Power Station, will raise the PTAL for parts of the area from 3 to 6.

Source: Adapted from TfL (2015), "Assessing transport connectivity in London", Mayor of London and TfL (n.d.), Transport for London, "Accessibility and Connectivity", https://tfl.gov.uk/info-for/urban-planning-and-construction/transport-assessment-guide/transport-assessment-inputs/accessibility-analysis

PTALs are complemented with other location-based contour accessibility indices. Among these are travel time maps, which calculate and represent the time required to travel from zone to zone across London, based on likely public transport routes. Travel time maps can show average times to a location from all other locations, average times from a location to all parts of London, or an average of both. Analysis is based on travel time between SAPs and service egress points (SEPs); it does not account for walking time to SAPs. A tool for calculating the TIM (as TfL calls its time mapping index) and developing related heat maps is also available as part of WebCAT.

While PTALs capture the impact on local accessibility to public transport, travel time maps provide a tool for evaluating the metropolitan-wide impact of transport improvements. Also, while PTALs are calculated for the aggregate of available public transport modes, the TIM is available for individual modes (e.g. step-free public transport, buses only), and thus provides information on accessibility for various types of users. More complex indicators are built from this analysis (Box 1.2). However, as the calculations become complex, these are not available in the WebCAT framework and are used by TfL for more specific analysis.

TfL also uses catchment analysis, setting a certain time threshold and calculating the area holding a number of opportunities at reach (e.g. jobs, colleges) or the area from which people can travel to a certain place within the time threshold. As with travel time maps, analysis can be conducted for individual public transport modes and can use either TIM or CAPITAL travel time (Box 1.2). Catchment area analysis has been used to prove the benefits of investments in the transport network in terms of additional opportunities at reach. All the TfL accessibility indicators described here are calculated for both current and future scenarios, which makes them useful in evaluating the impact of alternative policies and infrastructure projects.

Box 1.2. **TfL's CAPITAL and ATOS indices**

A more detailed version of the TIM framework, called the Calculator of Public Transport Access (CAPITAL) index, incorporates walking time to SAPs and from SEPs. In addition, the Access to Opportunities and Services (ATOS) index builds on the CAPITAL indicator by setting as destination the nearest employment, education, health, food shopping and open space facility that can be reached when travelling by public transport or walking. These indices serve to enhance the accessibility analysis by linking ease of access with attractiveness of area. Average travel times between an origin and the chosen destinations are calculated. An ATOS index is calculated for each type of facility and has particular selection criteria (e.g. the nearest 10 000 low qualified and high qualified jobs or the nearest three primary schools, secondary schools and further education institutions). Adding the ATOS index makes the analysis of accessibility even more comprehensive.

Source: TfL (2015), *Assessing Transport Connectivity in London,* http://content.tfl.gov.uk/connectivity-assessment-guide.pdf

While location-based contour indicators are valuable tools, they have their limitations. Their disadvantages are inherent in the way they are constructed. As binary indicators they treat all opportunities that are within the selected threshold (e.g. a 60 minute commute) as equally attractive and all that are not as equally unattractive. This entails ignoring user perspectives on the desirability of opportunities that are located at different distances and that imply different travel time and cost. The problem is more extreme when indicators simply express the total number of opportunities or facilities that are reachable within the time or distance thresholds set. In some cases, where indicators are represented in terms of time or frequency levels, such as PTAL or time mapping, opportunities or facilities that lie within the threshold are differentiated to a certain extent. However, even in these cases the indicators do not capture the way higher journey times or lower service frequencies affect the desirability to users of opportunities or use of facilities (e.g. transport stops). Another limitation is that the function on which the indicators are based captures changes in land use and transport but is not designed to capture interaction between them (Geurs and Ristema van Eck, 2001).

Potential accessibility indicators

More complex location-based accessibility indicators, often referred to as potential or gravitational, are better suited to address the issues described above. Such indices measure the accessibility of all opportunities in an area vis-à-vis all other areas, and a continuous basis rather than by applying a binary function. They weight opportunities by a function that simulates the reduction in desirability of an opportunity/facility in relation to the cost of travel (e.g. in terms of distance, time, and money). This term of the equation is often called a cost sensitivity or impedance function. In addition, changes in the land use and transport components of this type of function weight each other and make it possible to capture interactions between them. Solving these two issues significantly improves the accuracy of results compared to those obtained by using contour indicators.

Work developed at the Catholic University in Chile uses these tools for the analysis of accessibility by public transport in Santiago. In addition to the advantages offered by using potential indicators, the work takes into account information on users' perspectives on journey comfort and convenience to correct travel time. It also incorporates additional analysis on elements of the urban environment that have a relevant impact on inequality in access to opportunities and basic services across income levels.

The analysis breaks down the stages of travel into two potential accessibility indicators: one measuring accessibility to public transport stops (Physical Accessibility Index, PAI), and one measuring connectivity and quality of service provided by the transport system from the transport station of origin to the station of destination (Public Transport Index, PTI). A third indicator is inspired by the ATOS indicator developed by TfL and is used for measuring the attractiveness of destinations (Attractiveness Land Use Index, ALUI). A short description of the three indices is provided below. A detailed explanation can be found in Chapter 3 of this report.

- *Physical Accessibility Index*: the PAI calculates walking accessibility to the ten closest transport stops, within a threshold of 400 metres. The index has an impedance function which uses the walking time calculated for reaching each stop to weight the accessibility score assigned to each of them. An Environment and Urban Quality Index (EUQI) is developed in parallel, assessing sidewalk and street quality by using Santiago's pre-census data, which include information on public space. Four subindices are calculated and summed together to make up the EUQI: security/safety, environment, cleanness and infrastructure quality. Given the difficulty of calculating the effects of the EUQI on time perception, which would be needed in order to include it in the impedance function, the EUQI is left as an index that complements the PAI when analysing walking accessibility.

- *Public Transport Index:* the PTI calculates the total time between the first and last public transport stop in a trip. It incorporates user perception by distinguishing and assigning different weights to time spent in different types of activities during the journey (waiting, walking for transfers and in-vehicle time). It also incorporates weights that account for differences in comfort (e.g. crowding and standing vs. seating). Total time is expressed in terms of in-vehicle travel. This index also uses an impedance function to weight attractiveness of routes according to differences in the total time they require (in turn corrected by differences in comfort and time spent in different journey stages).

- *Attractiveness Land Use Index:* the ALUI identifies the attractiveness of various areas of a city in terms of the concentration of activities. It is calculated as the share of trips attracted due to a range of purposes (e.g. work, education, health).

Analysis using the three indices was carried out to evaluate and compare public transport accessibility conditions in two areas of the city that have similar trip characteristics for reaching Santiago's central business district (CBD): Las Condes and San Miguel. The two present significant income differences, having average monthly revenues per household equivalent to USD 3 260 and USD 1 480, respectively.

Values calculated for the PAI provide very accurate scores for walking accessibility to public transport, accounting for the reduction in the attractiveness of each stop relative to walking time increases. Results show that the CBD has the highest walking accessibility to public transport (0.78/1 on average), followed by San Miguel (0.64/1), with Las Condes having the lowest average accessibility level of the three (0.45/1). However, EUQI results demonstrate that San Miguel has a significantly poorer walking environment than Las Condes and, to a lower extent, the CBD.

The contrasting PAI and EUQI results underline the importance of analysing walking accessibility to public transport by measuring both the quantity of public transport stops accessible within a reasonable walking time and the quality of the urban environment in which people have to walk in order to reach them. Having this comprehensive view can make better investment decisions possible, first by bringing attention to accessibility limitations in places like San Miguel, which on the basis of PAI-based analysis only would probably be given low priority for investments aimed at increasing walking accessibility to public transport; and, second, by, showing that in many cases, reducing public transport accessibility inequality between income groups is a matter not of increasing the quantity of transport services in lower income areas, but rather of investing in improving the urban environment.

Analysis using the PTI was also conducted in the selected areas and compared to results using an indicator that does not account for comfort and crowding, and does not weight time spent on walking during transfers, traveling and waiting, according to users' perceptions. Results show that according to the latter indicator, trips between San Miguel and the CBD would appear to be quite short, on average (18 minutes), and even slightly shorter than those made from Las Condes (21 minutes). Using the PTI shows a very different picture, however, with both trips having significantly higher on-board time when correcting for crowding and comfort (adding 10 minutes to a trip from Las Condes to the CBD and 15 minutes from San Miguel), and trips from San Miguel incorporating an additional 10 minute transfer. The final PTI result shows in-vehicle equivalent times of 44 minutes for a trip to the CBD from San Miguel and 32 minutes from Las Condes.

Finally, calculation of the ALUI confirms that the trips evaluated connect the population to an attractive area. The particular part of the CBD set as destination of both trips is ranked with this indicator as the 26th most attractive of 804 transport zones, especially because of the concentration of work- and study-related activities.

Data requirements for developing potential location-based accessibility indices are of course substantially higher than those for contour indices, limiting the extent to which the former can be used by cities that have poor data availability. In addition, even in cities with better data, like Santiago, expanding methodologies like the one presented for the whole of the metropolitan area has proven a time-intensive task. In the case of Santiago, data challenges are even higher since there are significant requirements for information about the urban environment to develop the EUQI and for data about users' perspectives and travel conditions to calculate the PTI. The high data requirements can also limit the extent to which the indicators can be updated – an important barrier for their extended use as part of metropolitan-wide planning frameworks. Still, given the valuable contribution that indices such as those developed for Santiago can make, progressively adapting data collection frameworks to facilitate their development is an important step.

Another challenge is that as these indices become more complex, they also become more challenging to communicate. Especially as they include more information, summing results into a unique measure that would be easier to compare carries an increasing risk of give high scores to areas where very bad conditions in a number of variables could be compensated with very good ones in other dimensions. These areas could, overall, be more problematic than areas with average but more homogeneous conditions, yet both would have similar ratings. With the aim of overcoming these problems, analysis of the work developed for Santiago stresses the need to analyse separately what each index says about accessibility in different journey stages, and different dimensions of transport poverty, rather than putting all into an aggregate index. Even so, as the work is further developed, efforts will be required to find simple ways to explain results and link them to the current planning framework in Santiago.

Housing and transport affordability indices

Assessing affordability of neighbourhoods by analysing housing and transport costs borne by their residents is based on evidence generated across countries indicating that a) housing costs tend to go up when housing is located closer to city centres or particularly attractive locations (with housing being priced out by office space in some cases) and b) transport costs tend to go up the farther residents are from central and attractive zones. The two contrasting trends imply that households' decisions that enable them to pay less for either of these goods will tend to increase the costs for the other. Better understanding and measuring this phenomenon is relevant due to the vital role these two goods have in terms of livelihoods. In addition, housing and transport costs, which are often households' two largest expenses, are highly determinant of the budget available for other goods and services.

Housing and transport affordability indices were explored in the roundtable using the example of methodology developed by the Center for Neighborhood Technology (CNT). CNT's methodology has been used in the United States for developing a national framework that calculates neighbourhood affordability within and across cities and generates maps that reflect results spatially. Some variations of the CNT H+T index developed at the University of Pennsylvania were also addressed.

Description and use of the CNT H+T affordability index

CNT's methodology is based on a simple formula that expresses the average transport and housing expenses paid by the average household as a share of the average household's income. Transport costs are estimated by a model that calculates the percentage of people traveling by a given mode of transport, and the cost incurred. Car ownership and travel as well as public transport are used as independent variables, and are in turn estimated using publicly available data sources that contain neighbourhood and household characteristics (Chapter 4 gives further detail on data sources and calculations). A neighbourhood is considered affordable if an average household there spends 30% or less of its income on housing and 15% or less of its income on transport.

The H+T affordability index has helped change narratives about affordability across regions and cities in the United States, bringing increased attention to the importance of considering transport costs when determining affordable locations. New York, for example, would rank 17th on the list of most affordable municipalities on the basis of housing cost only, but rise to 6th if transport costs were added to the equation. In contrast, Cincinnati would fall from 2nd to 8th most affordable municipality in a similar analysis. Making such rankings available has increased and enriched public debate on locations for future urban growth and the benefits of residing in more affordable neighbourhoods. The CNT H+T rankings are, for example, an important source of information used by the press when addressing urban development, transport and equity issues.

The index has also had an impact on public policy, being a useful tool for city planners, housing professionals and policy makers. Local governments (e.g. Chicago) have used it in developing regional transport plans and selecting optimal locations for housing development and transport corridors. It has also been used in the development of urban revitalisation strategies that give priority to the reduction of households' cost of living (e.g. by Ohio State for Cincinnati, Cleveland and Columbus).

Housing professionals have used the index to determine where to locate affordable housing. The San Francisco Bay Area, for instance, was identified as a location where housing costs put particularly high pressures on household budgets, as 50% of residents have housing costs exceeding 30% of income, while the national average is 30%. The trade-off between affordable housing and long and costly commutes was also identified as relatively high. The Bay Area has the country's second largest number of people with commutes that exceed 45 minutes, and the highest average share of household income spent on transport plus housing (65%). As a way to improve the situation, public and private enterprises (including the Metropolitan Transportation Commission) established the Bay Area Transit Oriented Affordable Housing Fund, which finances non-profit and for-profit developers, municipal agencies and joint ventures in the development of affordable housing and other community services near public transport (MTC, n.d.).

In some US states and cities, the index has been formally incorporated into the legal framework as an indicator that government agencies must use in making financing and siting decisions. Examples include the state of Illinois (using 45% of income as threshold) and the city of El Paso, Texas (using 50% of income as threshold). The H+T index has also influenced allocation of the Low-Income Housing Tax Credit, the primary source of funding for affordable housing in the United States. The funding is allocated competitively and on a state by state basis. Criteria for allocation include the number of affordable houses to be developed as well as their affordability. In around 10 states, considerations about the location of housing, linked to the H+T index, are incorporated into scores used for project rating, so the index has a role in the location of subsidised housing.

At federal level, the H+T index has been used by the Partnership for Sustainable Communities, a joint effort of the Department of Housing and Urban Development, the Department of Transportation and the Environmental Protection Agency. The partnership's objective is to incorporate principles of liveability into federal funding programmes, policies and legislative proposals (Office of Safety, Energy and the Environment, n.d.). A calculator allowing individuals to estimate locations' housing and transport costs or generate a list of locations that are compatible with a certain budget for housing and transport is available within the framework of the partnership.

Challenges and limitations of housing and transport affordability indices

As with accessibility indices, understanding the limitations of housing and transport affordability indicators is key to using them correctly. A first issue, which is shared with contour accessibility indicators, is the somewhat arbitrary threshold. The housing cost limit has its origins in the long-time belief that one should be able to pay for housing with around a quarter of one's wage. The level has progressively been raised to 30% but remains contestable, and choosing a different threshold could significantly change decisions based on analysis of the indicator. Moreover, the use of a threshold means neighbourhoods with transport plus housing costs that are similar, but below or above the threshold, are treated as completely different (affordable and unaffordable), while those greatly different but below the threshold as seen as equally desirable. As CNT's online affordability maps show, breaking down results into ranges of income shares spent on H+T helps reduce this problem, providing a more comprehensive view of affordability across a metropolitan area.

Another point is that, while representing a substantial part of household expenditures, transport and housing are not the only costs that can substantially affect a household's finances and are linked to location. In the US, for instance, public school is clearly "the elephant in the room", as suburban areas tend to have very good public schools while many urban areas with good public transport do not. Thus, in this context, differences in tuition expenditures are also important and highly correlated to housing location decisions along with housing and transport costs. As a general rule, conclusions reached through analysis based on transport and housing affordability indices need to be read with understanding of the effects of all costs that vary directly with geography in a particular context.

A third concern is linked to limitations in capturing differences in life stages and household preferences. For example, high shares of income spent on housing by younger households that have taken out a loan may represent less of a problem than if the same share of income is spent by older households, since in the former case this is an investment for future reduction of housing expenditures. In addition, households may simply assign higher value to housing or transport (e.g. owning expensive cars) and be spending high shares on this even when they could spend less. The need to adjust income data (accounting for transfers and savings, among other things) before using them for further analysis was mentioned earlier. Using a corrected measure of income, adjusted to provide a better idea about wealth than simple present monetary income earned, could be an option for better capturing some of the life-stage differences when conducting H+T calculations. However, it must be acknowledged that some factors will always be left out and that analysis based on housing and transport affordability indices need to take this into account for correct interpretation.

It is also important to recognise that further analysis concerning differences in household conditions across regions and neighbourhoods is necessary for a correct reading of results. For example, Washington, DC, is ranked as the most affordable place according to the H+T index both as a municipality and as a metropolitan area. However, the result is due, to a great extent, to Washington concentrating a high share of relatively high income residents. This might suggest that, while relatively affordable to the type of population it concentrates (those qualified for higher paying jobs), the area is not that affordable for the general US population.

Finally, as it focuses on average households and average prices, the H+T affordability index has an aggregation bias: a neighbourhood's H+T affordability level could indicate that it is highly unaffordable even though it is very heterogeneous and thus in reality has many houses that are affordable to low income residents. A very homogenous neighbourhood could present the opposite phenomenon, being rated as affordable while not having housing affordable to the most vulnerable.

Alternative indices and application to cities in developing countries

Work developed at the University of Pennsylvania applied and adapted the methodology for calculating housing and transport affordability indices to the Valle de México metropolitan area.[6] Results are shown in terms of other indicators, rather than the share of income spent by the average household. A first index shows the proportion of households burdened by housing and transport costs and is compared to the percentage of rent-only burdened households. A second index shows municipalities that would be affordable, on average, to a low income household (defined as one in the 25th lowest income percentile), taking into account housing and housing plus transport costs. A third indicator calculates the percentage of housing options that are affordable to a household in this income percentile. With this indicator it is possible to overcome the aggregation bias problem. In all three cases, thresholds set to define whether housing and transport are affordable or a burden are the same used for the CNT index: 30% of income spent for housing and 45% for housing plus transport.

The study for Valle de México shows that analysis based on a range of variations of H+T affordability indices can provide a more comprehensive picture, allowing examination of trends and answering diverse policy questions. Similarly to results from the CNT index in the USA, the first indicator shows that incorporating transport costs increases affordability of central locations and reduces affordability of peripheral areas. Focusing on low income households, the second indicator highlights that very few municipalities are affordable to them, on average, and Mexico City itself even less so. Nevertheless, as the third indicator shows, many municipalities that are unaffordable on average have a significant percentage of housing options within low income residents' means. It must still be acknowledged, though, that in most areas in Mexico City proper, less than 50% of housing is affordable for these groups and in the municipalities with the highest concentration of economic activities the share of housing affordable to low income residents shrinks even further – to less than 33% in Cuauhtémoc and 25% in Benito Juárez, for example. In contrast, peripheral parts of the metropolitan area have the highest shares of affordable housing options for lower income residents, even when the high transport costs are taken into account.

This work confirms that housing plus transport affordability indices have potential to support better policies in countries outside the United States, including developing countries. In addition it stresses that, despite contextual differences, cities across countries share relevant issues. One such issue is the general lack of mass transit investment in peripheral areas and the limited efforts to develop adequate projects to integrate suburbs into city transport networks. Another is the lack of consideration of affordability, including transport costs, by finance and construction businesses, as well as by the government agencies regulating these sectors. Valle de México offers multiple examples of the way these issues have led to catastrophic results for the population, developers, government and transport concessionaires. Very large low income housing projects in peripheral areas such as Huehuetoca and Zumpango were developed without any co-ordination with transport planning. They are far from stations on the main transport project linking Mexico City and the periphery (the suburban train) and lack good alternatives for commuting to central areas of the city. The limited transport services have contributed to many homeowners in these areas abandoning houses on which they had already started making monthly mortgage payments, causing significant losses for construction companies. In addition, despite its high quality, the suburban rail service is operating at half the projected ridership levels, requiring the operator to draw heavily on a contingency fund established with public resources. The federal government has had to provide unexpected resources to support the services operation (OECD, 2015).

Developing housing plus transport accessibility indices faces challenges in terms of data availability. In the case of Valle de México, the origin-destination survey provides information about rents and is useful for calculating public transport vehicle miles/kilometres travelled. However, the last such survey for Valle de México dates from 2007, which significantly undermines the accuracy of results in terms of reflecting present conditions. Moreover, the lack of information for other urban areas limits the possibility of developing a national framework allowing comparisons across metropolitan areas. Also, data limitations mean that calculating car ownership and car miles/kilometres travelled is time consuming in Valle de México, though this was not a major problem for the research presented since the authors decided to focus their analysis on public transport users, who make up two-thirds of the population, and most lower income residents do not drive.

Discussions at the roundtable noted, however, that focusing analysis on public transport users could result in failure to capture conditions for low income captive car users living in places with little or no access to public transport. Thus, future analysis including all transport users would be relevant.

Overall, as data differences across countries are high, the methodology for calculating all elements of housing plus transport affordability indices, especially vehicle miles/kilometres travelled, needs to be adapted to different contexts. Methodological differences would need to be acknowledged when making cross-country comparisons.

General conclusions about indicators examined

In addition to the detailed insights about each index presented above, the following general conclusions were reached during discussions:

- Location-based multi-modal accessibility and housing plus transport affordability indices are particularly valuable in providing insight into transport-poverty social exclusion across population groups and location. They have proven the value they can provide in multiple contexts if linked to improved policy analysis and guidance. In many cases these indices are complementary, since although accessibility indices could theoretically incorporate monetary cost along with time spent in journeys, having a separate index for affordability can be more convenient, especially as accessibility indices become more complex.

- Authorities and institutions supporting policy makers need to acknowledge that understanding and solving an issue as complex as transport-related exclusion requires developing a comprehensive set of indicators. Given their proven value for improving analysis, it is important to develop and use location-based accessibility and housing plus transport affordability indices. These must, however, be complemented with indicators that provide information on other dimensions of transport poverty and social exclusion, such as exposure to dangerous, unsafe or unhealthy transport conditions.

- There is a trade-off between the attributes of simple and comprehensive indices. Simpler indices are easier to calculate, update and communicate, which makes it more feasible to link them to wider evaluation and planning frameworks. But they often leave out relevant information on transport poverty and exclusion. Also, results of less sophisticated methodologies have shortcomings in terms of accuracy that more complex indicators can overcome. Given the pressing need for incorporating indices that can identify and measure transport-poverty conditions into land use and transport policy evaluation, it is important for authorities to start working with data that are already available. Even cities with limited data availability can use very simple indicators at first, while making efforts to collect better data and progressively improve the indicators they use. Overall, as the case of London shows, authorities may need to combine simpler and more comprehensive indices to strike a balance between creating more general assessment frameworks that are flexible, easy to update and can be shared with stakeholders, and having more detailed and complete tools to analyse key issues and review policy. Continuous efforts to improve data and facilitate their collection are needed in any case to increase indicators' accuracy and quality.

- Beyond analysis of their value as measurement tools, finding ways to better incorporate performance indicators into the assessment process and the framework for investment allocation is one of the biggest challenges for progress in reducing transport-related exclusion. While many programmes have started incorporating such indicators, going beyond occasional use to their systematic inclusion in transport and land use policy frameworks is vital.

Policy issues for deeper examination

Rethinking housing, urban renewal and transit-oriented development policies

Meeting housing demand is a central challenge for cities, especially during phases of high immigration from rural areas, and in particular for the lowest income residents. Authorities often respond with a narrow approach, implementing policies that target the housing deficit in isolation rather than formulating a wider urban development policy to ensure access to opportunities and services. The result in many cities, particularly in developing countries, has been the location of low income groups in remote districts that are poorly connected to the main city, but where cheap land is available for providing housing at low cost. Such policies have, to a great extent, shaped urban expansion in many cities, and the pace at which lower income housing is built in peripheries has accelerated with a shift from government-led to private sector construction.

Examples of the consequences for residents of these peripheries are highlighted above. Similar conclusions can be drawn from the example of individuals being evicted from centrally located slums in Indian cities to social housing in the peripheries. Analysis of the consequences for these residents was presented in the roundtable and Chapter 5 presents this evaluation in detail.

Pockets of informal settlements, or settlements that are not part of any government plan, are common to cities in many developing regions, from Asia to Latin America. The analysis in India highlights that as cities grow, the proportion of these settlements becomes higher. The trend reflects the relative attractiveness of larger cities due to the diversity of employment available for rural migrants, the main reason for immigration. The presence of slums in Indian cities has been recognised by authorities as a problem for decades, partly because of their low quality housing, but also because "clearing" slums is seen as necessary for improvement of central areas. Efforts at slum rehabilitation have been limited; policies of evicting slum residents to formal settlements in the peripheries have become the predominant strategy.

In Delhi, one major eviction was carried out in the context of developing the metro system. Many slum residents were relocated to the outskirts, 20-25 kilometres from their original location. Resettlement offered them the possibility of owning a property at a low cost, and their access to health and education was maintained or in some cases improved. However, accessibility to employment became significantly more limited. Before eviction, a high share of this population would walk or bike to most daily activities. The large distance between their new homes and the activities' location made this impossible. Thus they became reliant on public transport, which implied spending a higher share of their income on commuting. Moreover, the accessibility of public transport in the new locations is very poor, making their daily commutes quite time consuming. Their average distance to the nearest bus stop increased from 200 metres to more than 1 km, and frequency of bus services near the new settlements is low.

Eviction in Delhi shows the relevance of better measuring the mobility impact of policy interventions. It points particularly to the need for incorporating transport-related indicators (travel times and costs), particularly for reaching jobs, into housing quality definitions used for the evaluation and design of social/affordable housing programmes. In several cities (e.g. Berlin, Lille), social housing providers are increasingly acknowledging this need. Nonetheless, scaling this up to regional and national level policies is vital.

The subject is linked to a wider discussion on the urgency of housing/urban development and transport authorities setting common objectives, and again underlines the need to develop indicators, such as those analysed in the previous section, which can help co-ordinate decisions in the two sectors. In Rio de Janeiro, the Institute for Transportation and Development Policy (ITDP) has helped authorities in both sectors to incorporate accessibility indicators into their planning framework, setting the common goal of increasing the share of the population living within a kilometre of mass transport from 23% to 90% by 2050, and working together, along with civil society organisations, to develop plans making it possible to reach the target. Insight from Santiago confirms, however, the need to constantly improve the indicators used and to adjust policies in both sectors according to the shared objectives. In this case, adequate accessibility levels, measured in terms of distance to public transport stops, are a condition for planning permission for residential developments. However, the omission of service frequency has proved misleading, since many areas have very poor frequency even when there are many bus stops within the required walking distance. Also, many areas that are being urbanised are currently classified as rural and thus do not have to meet public transport accessibility requirements.

Developing gap analysis tools was identified as relevant to directing actions across sectors towards attaining social inclusion goals. These tools are composed of a set of indicators for benchmarking the characteristics of an area against those that would describe a community that meets transport needs for the poor.

Discussions also questioned the slum relocation strategy, stressing that revisiting the possibilities for slum rehabilitation would be a better option. In China, for instance, a few recent programmes have given residents the option to relocate or stay, and this has been key for the programmes' success and acceptance. Promoting higher-rise development in the rehabilitated slum areas has also been important in making the strategy possible. Further discussion on the situation in India regarding past efforts at slum rehabilitation brought attention to the importance and challenge of making housing ownership in these areas possible. Otherwise, people are not willing to invest in upgrades even if offered low interest credit through social programmes. In addition, the lack of property ownership becomes a barrier to credit allocation itself.

The case of Delhi is also a good example of the need for revisiting urban renewal and transit-oriented development (TOD) in the light of social inclusion. In Delhi, improving central areas and introducing the metro were clearly not linked to considerations of inclusion of lower income residents. As eviction was seen as part of the renewal strategy for central areas, the approach implied lower income residents moving out rather than benefitting from the renewal. Moreover, the metro is not a solution for the most vulnerable: mobility surveys show that it is mostly used by middle-class young professionals, and is unaffordable to lower income residents (even with a subsidy, the metro costs three to four times as much as bus service). Finally, 24% of the reclaimed land, which could have been used for upgrading the slums, remains vacant and a further 20% is dedicated to roads and parking, i.e. infrastructure used by a relatively rich minority.

Even where social inclusion is set as an objective of urban renewal projects, achieving it has proved challenging. In many cases, the projects have been shaped under TOD principles, i.e. organising redevelopment along mass transit corridors that serve as main transport axes, building high density development along these corridors and fostering mixed land use. While TOD principles have the potential to make urban renewal more inclusive, notably by focusing on improving public transport and non-motorised mobility, the effect of increasing land and property values tends to displace the poor. The case of the VNEB OA renewal project in London, mentioned in the previous section, illustrates this problem. Requirements for affordable housing were included as an indispensable component, but as the project is located in a central zone of high value (the last available part of the Central Activities Zone), incorporating high shares of affordable housing while making the necessary investments in infrastructure and securing attractiveness for investors has proved difficult. The painful decision was taken to fund the public transport capacity that the desired development will need by sacrificing higher shares of affordable housing (GLA, 2012).

Thus, while TOD seems necessary for a compact, environment-friendly and more efficient city, authorities need to be aware of, and address, the challenges to making TOD projects inclusive. With this aim, the ITDP has refurbished its TOD standard – designed to support authorities in making sure TOD projects meet a series of minimum requirements – to incorporate indicators that measure project performance in terms of equity. To meet the new standard, projects have to prove that they a) can minimise displacement of the poor, b) will include mixed income housing and c) incorporate mixed land use that includes a significant offer of jobs. While meeting these objectives may be challenging (as seen in the VNEB OA case), the need for explicitly incorporating them into the planning and evaluation of TOD performance seems unavoidable if authorities and supporting organisations are to find ways to make projects more inclusive.

Financial schemes that incorporate land value capture mechanisms have demonstrated considerable potential for solving, or at least reducing, the social inclusion challenge of TOD and urban renewal. Authorities can use future land value increments to attract private developers and investors, but need to ensure that a significant part of the value generated goes to meet policy objectives, including social inclusion goals. Otherwise these could on the contrary accelerate the process of low-income population displacement. In the case of London, resources from the Community Infrastructure Levy and tax increment financing have helped to close the funding gap for the transport infrastructure needed, such as the Northern Line underground extension. Without these funds, trade-offs between funding public transport infrastructure and enlarging affordable housing areas would have been even larger and probably a reduction of both would have resulted.

In the case of Metrovivienda, a programme developed for construction of social housing in Colombia, these mechanisms were used to increase cost recovery of urbanisation carried out by the government when transforming rural land into sites of affordable housing. This increased the margin for keeping housing prices affordable for lower income residents. In an early stage, Metrovivienda used land banking, but in later stages projects have been done by association with local landowners instead of by buying plots directly, dropping the land-bank system. Project implementation involves a planning framework including development of specific plans (*planes parciales de escala zonal*). The framework includes land-value capture mechanisms that can be used for development of the areas. First the authority can acquire parts of the area in exchange for urbanisation services. These zones can be used for urban amenities and social housing (among other uses) and therefore provide a way to recuperate urbanisation costs in the form of land. In addition, if the renewal plan for the areas is approved, the municipality can recover 30-50% of the price increase generated by the change from rural to urbanised land, the authorisations granted for specific land uses, or increments in the value of development rights in the area (Maldonado Copello and Smolka, 2003).

Unlike in the VNEB OA case, Metrovivienda projects have been located in more peripheral areas. However, they also have a TOD component, since providing housing units with good accessibility to public transport is an explicit objective. Housing location has therefore been planned in co-ordination with future extensions of the TransMilenio bus rapid transit (BRT) system. The use of land value capture mechanisms was also recognised as a central component of Chinese redevelopment projects.

The need to improve regulation of speculation in future land prices was acknowledged, as without this a common result of urban redevelopment and TOD projects is that a high share of housing built adjacent to public transport and with good amenities is acquired by investors and not necessarily by individuals who will occupy the properties. This tends to send prices even higher, further reducing the possibility for lower income groups to stay in the area; lower income residents who are priced out and have to move to other areas often miss out on the improvements in transport and other facilities. The problem is magnified when a large number of parking spaces are provided in developments, often due to minimum parking regulations, making these properties attractive to the higher end market, which includes more car users. In the case of Metrovivienda, a mechanism that allows prices to be frozen at pre-project levels was key to prevent speculation, allowing the government to acquire land at low prices in the land-banking phase. The mechanism continues to be central to the newer arrangement in which Metrovivienda associates with local landowners instead of buying plots directly, since non-participating landowners thus cannot ask for compensation at future land values.

Further examination of TOD also highlighted the need to carefully adapt the concept to a range of city sizes and characteristics. In India, for example, local governments have a strong focus on metro development. To a great extent this is because the national government has tended to favour this mode, for instance through the National Urban Renewal Mission, and offers local authorities financial support for metro projects. Hence metro has rapidly spread in India, from the biggest cities (Delhi and Mumbai) to smaller ones such as like Bangalore, Chennai and Jaipur. However, Indian cities, especially small and medium sized ones, have relatively short trips, high shares of walking and cycling, and high shares of low-income population. Metro projects are therefore not an adequate solution for these cities, and do not work as an isolated solution in bigger ones either. Rather, investing much more in adequate bus services, which make up the highest trip share after non-motorised modes even in cities like Delhi (about 20%), would be a more suitable model for introducing TOD principles into Indian cities. Strong focus should be placed on increasing pedestrian access to bus stops and enhancing the walking and cycling environment, since these modes are particularly key to the mobility system. Also, as bus services need to be able to avoid getting stuck in traffic, there is a case for considering BRT projects.

In addition, city planners need to acknowledge and incorporate many of the patterns of informal settlements, which have naturally yielded TOD characteristics and are adapted to the wants and needs of lower income residents in particular contexts. While not very high rise, informal settlements in India are quite dense. In addition they offer mixed land use and, most notably, a large offer of jobs (both formal and informal) for diverse skills, and important shares of public space. The widespread presence of street vendors and residents occupying public space has resulted in low rates of street crime. Moreover, street design is adapted to high shares of walking and cycling rather than to short car trips. As noted earlier, analysing the advantages of shifting towards higher rise development could be important for strategies centred on slum rehabilitation and promotion of centrally located social and affordable housing. The other characteristics and their advantages should be recognised as a version of TOD which is better tailored to the reality of lower income residents in Indian cities, and used as a model when developing urban projects. Analysis of urban patterns and social dynamics in informally planned settlements and their application in urban planning and design would certainly be useful for other cities, particularly those in other developing countries.

Making public transport subsidies efficient and financially sustainable

Subsidising public transport services has a clear rationale in the light of social inclusion and equity considerations. Among other compelling arguments is the notion that providing affordable public transport is a form of social investment enabling the most vulnerable to increase their human and social capital through access to jobs, medical care, schools, etc. Other arguments in favour of subsidies are based on the notion of mobility as a basic human right and thus availability of affordable public transport as a citizen's prerogative (Cervero, 2011). The arguments are supported by the experience of cities, notably in developing countries, where decisions not to subsidise public transport have resulted in the pricing out of lower income residents, isolating them from economic and social activities and/or resulting in their reliance on insecure and low quality informal or semiformal modes.

However, discussions of the adequacy of implementing public transport subsidies need to be framed in the context of many competing needs in a context of fiscal restrictions faced by governments. Subsidising public transport may mean not subsidising, or reducing subsidies for, education, health, etc. Moreover, from a theoretical standpoint, a superior solution would be to offer cash transfers that people can allocate freely to whatever they feel they need most.

There was consensus that, in practice, the possibility of offering cash transfers is limited by inadequate pricing of private modes and the consequences of granting cash transfers in such a context. One experience illustrating this is that of Bogotá, where cash allocations were given to formal employees for the equivalent of 20 public transport trips. Use of these resources by programme beneficiaries confirmed that mobility needs were high in their priorities. However, the cash transfer was often used as the first instalment on buying a motorcycle instead of being spent on public transport. The low prices of motorcycles in Colombia and many other countries reflect a failure to incorporate negative externalities (pollution, accidents) generated by these vehicles into the pricing framework. The impact of cash transfer programmes on increasing motorcycle ownership and use, and their related social costs, is an important reason why authorities in Colombia and elsewhere have shifted affordable transport strategies towards a focus on subsidies. These are also seen as a way of securing demand for the public transport system, which is significantly reduced due to under-pricing of private vehicles.

Given the various competing needs and limited resources, public transport subsidy schemes need to find ways to put as little strain as possible on public finances, prove that they allocate resources efficiently and show that subsidies are effectively translated into livelihood improvements (which go beyond travel time savings). Programmes across countries have differed in whether subsidies are granted to operators or directly to the public; either way, a range of schemes exists. A common challenge, notably in the case of subsidies granted to operating companies, has been preventing subsidies from becoming disincentives for operational efficiency rather than contributing to poverty alleviation. In the case of schemes that grant subsidies to users, targeted subsidies are better suited than generalised ones to strike a balance between reaching financial sustainability and addressing affordability. Targeting those who really need the subsidy is not that straightforward, however. In many cases, schemes simply grant subsidies to easily identifiable groups considered as vulnerable or as often having few resources (e.g. the elderly, students). Due to the frequent mismatch between these categories and lower income groups, such schemes have resulted in errors of both inclusion and exclusion, losing significant resources on subsidising travel by non-poor residents while leaving high shares of the poor without support. Thus, at least in terms of equity, programmes designed in this way are badly focused.

A targeted subsidy scheme in Bogotá addressed this problem by building on Colombia's poverty reduction instrument, SISBEN (explained below), combined with the city's adoption of smart card technology. The case study draws attention to the potential for using such tools, both increasingly available elsewhere, to develop a scheme that can secure high quality and affordable public transport while ensuring financial sustainability. In addition, it provides insight on issues that could put the success of such programmes at risk and offers lessons on the conditions authorities need to guarantee when implementing them. Findings are presented below, separated into two main stages: setting tariffs and targeting beneficiaries. A description of elements of Bogotá's programme is provided as part of the analysis. For a more detailed examination of the scheme and its implementation (see Chapter 6).

Setting tariffs

Tariff setting was recognised as a key element for success in reaching financial sustainability. The following elements of this process were identified as fundamental:

Developing a solid methodology for calculating costs. Obtaining sufficient information on operating costs so as to determine cost-recovery rates is a key but challenging process, particularly for cities in developing countries where, as in Bogotá, the introduction of smart cards and implementation of integrated transport systems are part of a wider process of bus reform. In such contexts, formalising services previously provided by semiformal operators entails changes (e.g. paying fair wages, including safety standards on vehicles, renewing fleets) that in turn entail significant costs. In some cities these costs have been thought to be offset by the gains in efficiency that come with shifting towards a system with more rational routing, larger buses, etc. However, without solid cost estimation methodologies, it is impossible to know whether this is so; real costs are often much higher than expected, putting financial pressure on the new systems.

Furthermore, social and political contexts can make it difficult for cities going through bus reform to move immediately to an open, competitive tendering process for granting route concessions. Giving preference to companies organised by incumbent operators may be seen as a social necessity so that companies have enough time to consolidate into professionally run, competitive operators and residents whose livelihood depended on the sector be integrated into the new system. In addition, incumbents often have political clout. While this is understandable, it must be acknowledged that the decision not to implement open competitive tendering reduces the extent to which efficiency gains can be maximised to offset the costs of formalisation. Thus, especially in cases where targeted subsidy schemes are part of a process of bus reform, there is a need for detailed scrutiny of the costs of formalisation and limitations on efficiency gains in bus operations imposed by the social and political context. This is particularly important as bus operating costs constitute 70-80% of the technical tariff.

A strong point in the Integrated Transport System (Sistema Integrado de Transporte, SITP) in Bogotá has been the use of bidding for each element: trunk routes, feeder routes and fare collection agent. This has provided benchmarking information to calculate the average technical tariff needed to operate the system at cost-recovery level (the administrative costs of the public sector entity in charge of planning and managing the system are also incorporated into technical tariff calculations). While the real tariff is determined by the mayor, having a solid methodology behind it has been an asset in making the public aware of the need for tariff adjustments and allowing the mayor to set a price close to the technical tariff. Sometimes the price has even been set higher than the technical tariff, helping to offset deficits at other times. Bidding for routes is only open to companies formed by incumbent operators, limiting efficiency gains. However, requiring them to compete has been a significant advantage, especially compared to experience in cities where payment for bus operations has been set without benchmark information (e.g. Valle de México).

Another relevant point is the importance of estimating the effects of additional ridership on system capacity, which could imply a need to enlarge the fleet, entailing additional costs that should be taken into account. In Bogotá, analysis indicated that induced demand could be dealt with by operating the existing fleet. Still, this consideration should be borne in mind.

Implementing competitive tendering and setting a suitable contract length. While there may be reasons not to use open, competitive tendering for bus concessions in the early stage in cities going through bus reform, implementing open and competitive tendering must remain an objective in the case of privately operated services. Thus, such cities should set clear rules and schedules for shifting into this type of model in the medium term. Establishing a suitable length for concession contracts is an essential condition for ensuring this transition.

Setting an appropriate contract length is also necessary to prevent authorities from getting stuck in contractual arrangements that hinder the financial sustainability of transport systems. Even in cities where it is decided that open, competitive tendering should be introduced only after more than one concession period, an adequate contract length is important to make progressive adjustments to the agreed terms. In cities where concessions are already granted via open and competitive tendering, contract length has shown to be key in incentivising efficiency and continuously adjusting the system. For example, in London, bus concessions are granted through an open, competitive process with contracts of five to eight years. In Bogotá, concession periods for TransMilenio (trunk) corridors are 10 to 12 years, since in this case operators need the time to recuperate investments on fleet renewal. However, the 24-year contracts on other SITP route concessions have importantly hindered authorities' ability to reach financial balance.

Another important lesson for cities going through bus reform is that authorities should find ways to effectively encourage companies formed by incumbent operators to become efficient during the transition to open, competitive tendering and meet regulations that guarantee minimum quality and safety standards. This has been an important role of the bidding process in Bogotá. Authorities could also look into the introduction of quality incentive contracts similar to those used by TfL (Box 1.3).

Box 1.3. **London's quality incentive contracts for bus services**

Concession contracts stipulate a set of bonuses and deductions on bus service remuneration, depending on over- or under-compliance with the minimum performance standards established by the authority. Bonuses and deductions are applied to performance on waiting time, driving quality, internal and external presentation of vehicles and operated mileage. The contracts also establish an extension threshold, rewarding compliance with specific performance standards with an extension of two years in the concession.

Source: OECD, based on TfL (2008), *London's Bus Contracting and Tendering Process,* www.tfl.gov.uk/cdn/static/cms/documents/uploads/forms/lbsl-tendering-and-contracting.pdf.

Accurately estimating demand. Ridership estimates have been a challenge for Bogotá, as well as other cities in Colombia using similar models. Ridership estimates are at the core of accurate estimation of cost-recovery rates and therefore of finding financial equilibrium in the concessioning process. In Bogotá, estimates of demand in TransMilenio (trunk) corridors have been fairly accurate, but the other

SITP routes (feeder lines) have not had the expected demand. In cities including Medellín, Barranquilla, Cali, Bucaramanga and Pereira, overall demand has been significantly underestimated.

The exponential growth of private vehicle use (cars and motorcycles) in these cities has been identified as a central reason for the lower than expected demand for public transport services. This confirms the need for adequate pricing of the use of such vehicles, since on top of the environmental and health consequences of not doing so, underpricing significantly hinders governments' financial capacity for high quality and affordable public transport services. In the meantime it is extremely important to understand and incorporate these effects into demand estimates.

Identifying non-fare revenue sources, especially to cover major infrastructure investment costs. Ensuring high density along public transport corridors and implementing adequate parking control are important for securing public transport ridership, and with this increasing fare box revenue. Nonetheless, authorities need to recognise that fare box revenues are not sufficient to cover the major capital costs that public transport expansion and improvement entail. In the case of Bogotá, fare box revenues have been expected to pay for bus depots and infrastructure investment, putting a heavy financial burden on the SITP and underlining the need to find other sources of revenue to pay capital costs. In cases like that of Mexico City, BRT infrastructure costs have been covered by local government, separating them from fare box revenues.[7] Even so, covering costs for further expansion has been challenging and authorities would benefit from assigning secure funds to this. In addition, operating costs may also need subsidies, especially in cities where transport systems are going through significant upgrading/formalising processes and income inequality is high.

It was agreed that revisiting charging levels for private vehicles and introducing additional ones, if need be, would serve the double purpose of correcting underpricing while raising funds for investment in public transport infrastructure and operating subsidies where needed.

Correctly targeting beneficiaries of subsidies

Once an appropriate tariff is set, developing a solid methodology for effectively targeting beneficiaries is extremely important to ensure value for money by making sure subsidies are effectively translated into life quality improvements for the poor. In this respect the following actions were acknowledged as necessary:

Building on expertise developed for identifying beneficiaries of poverty alleviation programmes. The pro-poor targeted subsidy programme in Bogotá was designed using Colombia's means-tested System for Selecting Beneficiaries of Social Spending, known as SISBEN. The system is not exclusive to the transport subsidy scheme, but is designed as a technical and objective mechanism to select beneficiaries for poverty alleviation programmes across distinct sectors. It is based on a variety of indicators that measure socio-economic conditions from a multi-dimensional perspective, taking health, education and housing conditions into account, as well as variables measuring vulnerability. Design of a precise subsidy can be done by selecting specific variables to be used. The result is a score from zero to 100. In the case of the public transport subsidy, residents having a score of 40 or below are those who can benefit from the programme.

As data-intensive as SISBEN may seem, Colombia has not been the only country to have developed this kind of tool. Other countries, including Brazil, Chile, Costa Rica and Mexico, could consider developing similar schemes, building on their own systems. Nor would it be impossible to introducing such tools in countries that do not have this kind of system. Argentina, for example, has been targeting beneficiaries using selection processes from other programmes, which, although lacking the comprehensive methodology, can still be useful. Using geographical targeting may also be a good option in the absence of such tools. The fact that smart cards are increasingly being introduced across countries makes the model a feasible option for many cities, not only in Latin America but also in countries outside that region, such as India.

Taking measures to avoid fraud. Authorities in Bogotá have had to develop measures to avoid abuse and the creation of a black market for subsidised tickets. A first measure was to personalise the smart card with the beneficiary's name and picture. Subsidised cards cannot be validated twice at the same station within 30 minutes. And subsidised trips are capped at 20 a month, a level corresponding to the objective of subsidising only commuting trips. Although authorities are studying additional measures, the ones described seem to have had reasonably good results. In fact, studies have shown that fraud among subsidy beneficiaries is much less than general fraud in the system.

Continuously updating data used for beneficiary selection. The public transport subsidy scheme in Bogotá has benefited considerably from the fact that SISBEN is revised every three years, so potential new beneficiaries can be identified. A challenge, though, is that, even when updating the database, it is hard to get people off the subsidy once it has been granted.

Conducting impact analysis for assessing and adjusting program design. Impact evaluation conducted in Bogotá has provided useful insight on the success of the scheme. Results confirm that the subsidy has attracted new users to the SITP. In fact, 134 000 of the 160 000 cards with subsidy that have been validated went to new users. The evaluation also reveals that there are no effects on beneficiaries' total transport expenses; instead, people benefit from the subsidy by increasing the number of trips they make. Thus, the subsidy has helped to overcome the lower frequency of motorised trips made by lower-income people in Bogotá. On average, each recipient uses the SITP system ten extra times a month. Also, the subsidy has a significant effect on the hourly income of informal workers (not correlated with an increment of hours worked), although no effect was found in terms of employment status or education access. The latter can probably be explained by the fact that, since the subsidy is only granted to the lowest segment of the poor, solving constraints other than transport could be crucial for them to shift from the informal to the formal labour market or to gain access to better education.

The impact evaluation also focuses on understanding individual characteristics related to receiving the subsidy. Results show that, within the eligible population, the employed, women and those with higher income and education levels are more likely to get the subsidy. The role of education level suggests that the process may be too complicated for the least educated people. Finally, word of mouth, i.e. the fact that word about the existence of the subsidy was spread within communities of lower income residents, also played a large part in increasing the number of eligible people applying for it.

Follow-up on the programme continues. One evaluation is reassessing the number of trips subsidised per user as well as the percentage of the subsidy, with the purpose of readjusting both as necessary. The point was raised that evaluations on the impact of the subsidy on the SISBEN score, as well as on motorcycle ownership and use, would be very useful.

Identifying appropriate communication and dissemination strategies. Reaching potential beneficiaries has been challenging, a fact that highlights the relevance of continuous analysis and adjustment of communication and dissemination strategies. At first the TransMilenio transport agency relied on radio and television. However, it soon became obvious that this was costly and not very effective. TransMilenio found that a better option was to partner with local health and education subsidy programmes, leveraging their leaders' expertise in reaching out to people. In addition, when the programme began, people had to go to designated sites to apply for the subsidy. After it became evident that this approach had its limitations, vans were dispatched to regions with concentrations of low income people.

Adjusting communication and dissemination strategies has allowed the number of beneficiaries to grow significantly, but it is still marginal compared with the share of the poor in Bogotá's population. It was pointed out that it may be necessary to move towards a model where potential beneficiaries are identified through a tool such as SISBEN and given the subsidy automatically. Experience in Chile, for instance, shows that individuals often are uncomfortable with asking for subsidies. The question was raised whether it might be a good idea to disseminate information on the subsidy along with that on housing rentals, making landlords marketing agents. In Bogotá and many other developing cities, however, lower income people are often in the informal housing market. Still, further consideration of this model could be useful for more developed countries.

One limitation of the subsidy scheme in Bogotá is that it applies only to residents of the city proper. This means many poor people living in peripheral areas like Soacha, from which almost 1 million residents commute daily to Bogotá, cannot benefit. Extending the subsidy to Greater Bogotá, therefore, is an important option. Bogotá is looking into setting up a metropolitan transport authority, which, among other benefits, would facilitate extension of the scheme. Establishing such an agency, however, is a complex political and institutional process.

The point was also made that while public transport subsidies can certainly address the affordability dimension of transport poverty, they do not necessarily contribute to solving time poverty, i.e. the fact that low income residents, especially women, face significant restrictions in carrying out necessary activities due to long travel times (often because they live in remote locations) and low service frequency. Being able to afford faster modes can help reduce time poverty for many, though improving land use and housing policies to decrease travel distances is also crucial for solving the problem as a whole.

Finally, discussions emphasised that using targeted subsidies can enable authorities to strike a balance between choosing a tariff model that can lead to efficiency (distance-based fares) and addressing social issues these may raise. In many cities, flat fares are chosen over distance-based fares because the latter are seen as unfair to residents who can only afford housing in the peripheries and as penalising the poor more generally as they tend to travel longer distances. However, flat fares have major shortcomings, as they are not cost-effective for transport systems and imply subsidising and thus incentivising sprawl. Applying distance-based rates and providing subsidies targeted for lower income residents can help resolve the trade-off, allowing a better balance between efficiency, making people and activities become more sensitive to the distance between a given location and the rest of the city, and equity considerations.

Improving clarity on social issues linked to transport demand management policies

Claims that transport demand management (TDM) policies, particularly congestion pricing, are unfair often underlie public disapproval and a related lack of political will for their implementation. However, it is seldom clear what people mean by these policies being “fair” or “unfair, making it hard to establish whether there is truly a valid argument for discarding or rejecting them and thus missing out on the overall benefits their implementation could bring.

With the aim of improving understanding on this issue, work by the KTH Royal Institute of Technology analysed the case of four middle-sized European cities that either apply congestion charging systems (Stockholm and Gothenburg) or have solid plans to do so (Helsinki and Lyon). The cities all have a historical city centre surrounded by more recently developed areas.

The analysis, presented as part of the roundtable, takes as its departure point two perspectives from which to examine the fairness of congestion charging and of TDM policies more generally. The first is that of consumers, which is based on analysis of effects across income groups and relies on traditional equity analysis. The second is that of citizens, which aims at identifying the extent to which the main principles underlying these policies are aligned with societal preferences. The main findings and debate generated by them are below, and the full evaluation can be found in Chapter 7.

The consumer perspective

Analysis based on the consumer perspective revealed that higher income people in all four cities pay (or would pay, in the case of Lyon and Helsinki) more in congestion pricing tolls simply because they drive more, especially in central areas. Lower income people, on the other hand, pay a higher share of their income, making the policy regressive. In fact, the differences between the income shares paid across income groups might even be greater if only car owners were considered (there are fewer of them in lower income groups), instead of total population of driving age, as in this study. Acknowledging the regressive distribution of the policies' impact is of course important in identifying whether particular groups carry a disproportionate burden and should be compensated. But whether this is to be judged as unfair depends very much on the main purpose of the policies put into place.

If policies such as congestion charging or parking fees are intended to raise revenues and are found regressive, the case for their unfairness is a valid one, as with any regressive tax. It must be stressed that congestion charging is a very expensive way of raising revenues, and not recommended if that is the intention. This was one of the main conclusions reached during an earlier roundtable on congestion pricing (ITF, 2010). If, on the other hand, the main purpose is to correct pricing by better reflecting the social cost of driving, the case for the policies' unfairness is rather weak. Judging price-correcting policies as unfair is equivalent to asserting that low income car users have the right to subsidised car use. While governments need to ensure affordable transport, it does not need to be by car. It must be noted that the case of TDM policies aimed at price correction is in fact very similar to that of other corrective taxes (e.g. on carbon or petrol) that are increasingly being adopted worldwide, and whose distributional aspects have long been discarded as a reason against using them, at least by most developed countries and transport experts.

Nevertheless, providing good transport alternatives, particularly for captive car users who would spend a large share of their income on travel as a result of their implementation, is central to ensuring that TDM policies are equitable and deliver their full potential. If high shares of drivers have no alternative to paying the toll, congestion levels and externalities such as pollution will simply remain, and the only change will be the creation of a disproportionate financial burden for part of the population. A study of Madrid discarded the policy for these reasons, since a large share of residents travel from the south to the north of the city and the difference between traveling by car and using public transport would be more than an hour.

To avoid a similar problem, London accompanied its congestion charging system with significant upgrades to bus services. In Stockholm the many city-provided alternatives – e.g. a quality public transport system, park and ride facilities, unpriced bypasses and congestion charging with time-based differentiated rates – have been identified as key to the success and acceptability of the policy. The case of Stockholm also highlights the fact that transport patterns are often more flexible than authorities might expect, thus showing that there are high margins for users' adaptability to a policy like congestion pricing. Studies in Stockholm showed that 75% of drivers going through the congestion charging area were not daily users but rather individuals driving through two to three times a week, and that the biggest reductions in congestion came from these drivers reducing their travel through the area to one or two times a week. The policy had a significant effect in reducing private car trips (by about 30%), half of which shifted to public transport.

Re-examining the findings in the context of cities of developing countries highlights interesting differences. Such cities have significantly higher shares of the population, and especially of lower income residents, relying on public transport. This means TDM policies are potentially not regressive in developing country cities. In fact, congestion in central areas of such cities, largely caused by drivers but reducing speeds the most for public transport, is in itself very regressive. Analysis of potential congestion charging schemes in Beijing and Delhi confirm this, showing that it is not the poor but rather lower middle income residents for whom congestion charging would represent a higher cost. Of course, given the high income inequality in most cities in developing countries, incomes of lower middle income residents are still likely to be quite low. However, the much more limited transport alternatives, especially in poorly connected peripheries, as well as the higher concentration of low income residents, mean that careful analysis is particularly important to identify the extent to which mobility of individuals (whether low or lower middle income) would be hindered as a result of TDM policies. As has already been noted, such policies' fairness and success depends on creating alternatives and analysing compensation for individuals who do not have these alternatives while these are made available.

An additional point raised was that the design of a congestion charging system and the legal framework to which it is subject could affect its distributional effects. In Sweden, the tax court determined that congestion charging was part of a car's operating costs and thus included in the "taxable benefit value" of a company car. In other words, depending on company policy, company car users either do not pay the charge or deduct it from their before-tax salary. Data from Gothenburg show that this exemption significantly reduced average toll payment from the highest income groups, considerably increasing the scheme's regressiveness. This example highlights the importance of carefully analysing the effects on a policy's impact distribution of any exemption, whether imposed by the legal system or proposed as part of its design (e.g. for local residents or professional traffic).

Finally, analysing user attitudes towards congestion charging schemes can improve understanding of a scheme's potential support. Surveys in the four cities confirmed that the amount of the existing or proposed toll is negatively correlated with individuals' support for the system, with the biggest difference in support between those who do not pay at all and those who pay already something. Beyond this, drivers who value time are more supportive, and being in a city that already has a such scheme is a factor in higher support (perhaps because some of the system's benefits become evident). Finally, unsurprisingly, not having a car is positively related to support for such a policy.

Overall, an important finding is that income in itself is not a factor that is correlated with higher support of the system. Even in the case of a regressive system, a traditional equity assessment shows lower income groups seem to consider themselves better off than average (analysing the self-interest variables affecting their support of the policy).

The citizen perspective

Analysis from a citizen perspective was carried out by identifying three principles inherent in the concept of congestion pricing and in TDM policies more generally: allocation of resources according to willingness to pay; transfer of resources from individuals to the government, which in turn is linked to trust in the government to spend any revenues wisely; and the value of environmental improvements. The study derived a model from results of survey questions that separated respondents' opinion of the three principles from their opinion of the congestion charging scheme itself.

One interesting finding was that respondents in all cities rated pricing mechanisms for resource allocation as superior to queuing, having the government decide the allocation, or using a lottery (in that order). Respondents in all cities also strongly agreed on the need for environmental protection. Particularly relevant to the question of fairness was that there were no significant differences across income groups in considering pricing mechanisms for resource allocations as fair, although higher proportions of richer residents agreed with this. In addition, higher shares of poorer residents agreed that reducing differences between rich and poor was an important priority for the government. But overall the results gave scant support to the argument that the three principles were significantly better aligned to the utility of higher income residents.

Comparing perceptions of these principles and attitudes towards congestion charging schemes as such reveals that the way a scheme is framed can determine its acceptance. In particular, if the scheme is seen by as a tax, it will be closely linked to perception of taxes. Thus, where residents think taxes are too high already (as is the case in most cities in the study), acceptance of the policy will probably be limited. A scheme framed as an environmental policy would have a better chance, as residents of all four cities strongly accepted that principle. Thus, in addition to using TDM policies to correct prices rather than generate revenue, for the sake of "fairness", effectively framing them as such and highlighting the expected benefits (e.g. environmental improvements, reduced congestion) seems to be key to their acceptance. In Stockholm, the fact that the government did not specify a particular use for the revenue was perceived as proof that this was not the policy's main purpose, which contributed to the city's success in winning public acceptance for it.

Nevertheless, even in cases where TDM policies' main purpose is not raising revenue, they are not necessarily revenue neutral. Citizens' perspective on the government's trustworthiness to allocate the revenues is therefore another determinant of support for TDM policies. In other words, while it is important to make clear that their main objective is not to raise revenues, it is also useful to communicate that any revenues raised will be used in a way that makes sense to the population. In general, investment of the revenues in public transport improvement has been acknowledged as appropriate. In London, for example, even though legislation specifies that the main use of a congestion charging scheme cannot be to raise revenues, surveys revealed that raising money for public transport by this means would be widely accepted.

It should be borne in mind that, if TDM policies are not cost-effective or appropriate instruments for raising revenue, but having high quality transport alternatives is necessary for their success and acceptance, governments must find other financial sources for investing in developing these alternatives. An interesting case from the United States shows that in a referendum in Los Angeles voters favoured sales tax increments for making substantial investments in improving the public transport system and facilities for walking and cycling. The agreed package would allocate 25% of the revenues raised to support operating costs of the public transport system. In addition, up to 20% could be reserved for connecting local walkable roads and thus would be an incentive for redevelopment around public transport stations. The remaining 55% would be dedicated to the construction of 13 metro lines. Overall, the package was framed as the way to buy a public transport system in the present by committing future payments to it (as an individual who buys a house would do). With this model a mobility system that would normally take around 30 years to be built would take 10-15 years.

Attempts in the United States to implement TDM policies, notably regarding parking restrictions, have cost several mayors their next election. The case of Los Angeles raises the question of whether TDM policies would have a better chance if framed as part of a larger package that could correct pricing while helping to significantly improve alternatives to private vehicles in the short term, both with the relatively low revenues from TDM policies themselves (if these are not revenue neutral) and with other revenue sources.

Priorities for future research and discussion

This last section covers subjects participants recognised as relevant to continue moving forward in reducing transport-related exclusion. It briefly describes the main points raised as essential to consider when addressing each topic.

Understanding the role, potential and limitations of shared vehicles for tackling social exclusion

As in other sectors, the introduction of new technologies into transport services is seen as promising for improving their efficiency. The assumption is that technological applications will allow demand aggregation and make services more productive. But better understanding of the extent to which this assumption will materialise, especially in a range of contexts, is still needed. For instance, transport services in cities in developing and developed countries are going through distinct processes. Among other things, the former are trying to better rationalise routes, increase wages for drivers, move towards centrally planned systems and reduce the number of service providers in atomised markets. Developing country cities also have high shares of low capacity vehicles that, although semiformal, have developed rather flexible routes. In contrast, cities in developed countries have far lower shares of low capacity vehicles and are trying to find ways to introduce more flexibility into planning and operation of transport services, especially to reduce high labour costs. Thus, the ways shared vehicles could help advance objectives differ widely in different contexts, which also implies that the main benefits of their introduction can also vary significantly across cities and countries, as can their distribution across income groups. It is therefore necessary to focus new research on better understanding the potential role and limitations of these services under a range of conditions, and the policies that could best materialise their benefits. Impact on public transport ridership and the potential risk of increasing congestion should be analysed.

Regarding the specific potential of shared vehicles for helping reduce social exclusion, a question yet to be answered is whether gains in productivity brought by technology would allow provision of affordable services for lower income residents, or if subsidies would still be needed for this. Answering this question will be key, especially in cities with concentrations of lower income residents in low density developments in the peripheries, which will present the most problems in making a business case for operators, even with applications that can optimise services.

It will also be important to make sure not only that new models and real life testing of the impact of shared mobility look at maximising accessibility as an indicator of success, but also that the question of whether vulnerable residents would be left out is explicitly addressed, i.e. that what is maximised is "inclusive accessibility". Analytical tools for understanding whether this is an outcome must be improved, since even using common equity indicators such as the Gini coefficient could be misleading: the coefficient can improve when accessibility differences across income groups are reduced even if the most vulnerable are not necessarily better off.

Correcting policy biases and market distortions

Developing additional programmes and projects for reducing social exclusion is relevant. However, much of what needs to be done to move ahead with the inclusive transport agenda involves reforming transport and land use policy and appraisal to remove bias towards automobile travel over more affordable modes. Revisiting zoning codes should be a priority, especially those with minimum parking requirements, which make it more difficult to develop affordable housing in in-fill developments. Restructuring transport project evaluation and funding allocation frameworks is also vital where these are based on traffic indicators and thus systematically favour road expansion over low-cost transport modes. Another issue that needs to be addressed is that while public accounts treat public transport subsidies as explicit, current automobile subsidies are virtually invisible to the public and generate social costs that are being ignored.

Attracting investment to the reduction of transport-related exclusion

Finding more effective ways of attracting investment to advancing the inclusive transport agenda should also be a priority. The following strategies were identified as promising and worthy of further examination:

- *Improving and complementing appraisal tools*. While cost-benefit analysis can be improved (e.g. by including travel times corrected by user perspectives), the instrument is not well suited for capturing changes in the distribution of opportunities spatially. It is also difficult to adjust weights to give preference to benefits to lower income groups within its framework. Thus, there is a need to explore ways to complement cost-benefit analysis to ensure that social inclusion benefits are valued in the assessment process. The Distributional Impact Appraisal framework in the UK, for instance, is designed to accompany cost-benefit analysis and capture the social and distributional impact of transport interventions. The framework uses eight indicators: user benefits, noise, air quality, accidents, security, severance, accessibility and affordability. These are looked at across groups of people with different socio-demographic characteristics (DfT, 2015).

- *Calculating and adding co-benefits in other areas to make cases more solid.* Investing in reducing social exclusion often has benefits and/or opportunities for reducing many other social and financial costs. Health and environmental benefits, for instance, are significant co-benefits of investing in public and non-motorised infrastructure. Yet explicit calculation and communication of co-benefits are rarely linked to efforts encouraging resource allocation to programmes and projects that aim at reducing social exclusion.

- *Linking funding sources to transversal programmes.* While there is growing consensus about the need to co-ordinate planning on housing/land use and transport, there is little understanding of the main barriers preventing cities and countries from doing so. A large part of the answer may be that it has not been possible to assign significant resources to programmes that set transversal objectives (e.g. poverty reduction, improved accessibility for the most vulnerable), which are shared across sectors. Thus, while in many cases it is clear that current housing and transport programmes are not yielding optimum results and are even creating undesired conditions, they are still much more successful in scaling up actions than new initiatives that, although better designed, remain marginal. Looking into ways to shift financial and institutional resources from silo-structured to multi-sector programmes and projects should be high on the agenda. Capacity building for inside institutions leading the various sectors is key.

Aligning the institutional and assessment frameworks for public funding of transport investment with policy objectives for sustainable mobility and social inclusion is always central to delivery and often the Achilles heel of policy implementation.

Notes

[1] The term "functional urban area" refers to the core city plus peripheries that are part of the same economic unit (OECD, 2012).

[2] The maps are developed using weighted averages and based on the population of census blocks for aggregating results into larger areas.

[3] Average time takes into account both walking and in-vehicle travel time in the case of public transport.

[4] SAPs group public transport stops in very close proximity (TfL, 2015). The thresholds are 640 metres for bus and 960 metres for rail, corresponding to walking times of about eight and 12 minutes, respectively, at a walking speed of 4.8 kph (TfL, 2015).

[5] Level 1 corresponds to the lowest accessibility and 6 to the highest. Levels 1 and 6 are each subdivided into 2 categories (TfL, 2010).

[6] Valle de México is the metropolitan area containing Mexico City and municipalities in two other states, including 59 municipalities in the state of Mexico and one in Hidalgo state (OECD, 2015).

[7] This is only the case for Mexico City, not the rest of the Valle de México.

References

Cervero, R. (2011), "State Roles in Providing Affordable Mass Transport Services for Low-Income Residents", *International Transport Forum Discussion Papers,* No. 2011/17, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/5kg9mq4f4627-en

GLA (2015), "The London Plan: The spatial development strategy for London, consolidated with alterations since 2011", Greater London Authority, London, https://s3-eu-west-1.amazonaws.com/file-respository/London+Plan+March+2015+(FALP).pdf.

GLA (2012), "Vauxhall Nine Elms Battersea Opportunity Area Planning Framework", Greater London Authority, London.

ITF (2010), *Implementing Congestion Charges*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789282102855-en

Kenyon, S., G. Lyons and J. Rafferty (2002), Transport and social exclusion: Investigating the possibility of promoting inclusion through virtual mobility. *Journal of Transport Geography*, 10 (3), pp. 207-19, http://eprints.uwe.ac.uk/8903.

Litman, T. (2011), *"Measuring Transportation: Traffic, Mobility and Accessibility"*, Victoria Transport Policy Institute, March, 2011.

Lucas, K., G. Mattioli, E. Verlinghieri and A. Guzmán (forthcoming), Transport poverty and its adverse social consequences, *Proceedings of the Institution of Civil Engineers – Transport*.

Maldonado Copello, M. and M. Smolka (2003), Using value capture to benefit the poor: the Usme project in Colombia, *Land Lines*, Vol. 15, No. 3, Lincoln Institute of Land Policy.

MTC (n.d.), Bay Area Transit Oriented Affordable Housing Fund, http://mtc.ca.gov/tags-public/bay-area-transit-oriented-affordable-housing-fund, (accessed 5 June 2016).

OECD (2015), *OECD Territorial Reviews: Valle de México, Mexico*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264245174-en.

OECD (2012), *Redefining Urban: A New Way to Measure Metropolitan Areas*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264174108-en.

Peralta Quiroz, T. and R. Somik (2014), "Accessibility Analysis of growth patterns in Buenos Aires, density, employment, spatial form", *Transport Research Board*, Washington, DC.

TfL (2015), *Assessing transport connectivity in London*, Transport for London, London, http://content.tfl.gov.uk/connectivity-assessment-guide.pdf

TfL (2010), *Measuring Public Transport Accessibility Levels: PTALs – Summary*, Transport for London, https://files.datapress.com/london/dataset/public-transport-accessibility-levels/PTAL-methodology.pdf.

TfL (2008), *London's Bus Contracting and Tendering Process*, Transport for London, London, www.tfl.gov.uk/cdn/static/cms/documents/uploads/forms/lbsl-tendering-and-contracting.pdf.

Chapter 2
National issues in the USA in economic development, mobility and income inequality

Alan E. Pisarski
Alan Pisarski Consultancy, Falls Church Virginia, USA

This assessment of the present context for evolving socio-economic patterns and trends in the United States is intended to support consideration of prospects for gains in income shares among the lower income population, recognising that the United States is: a very large heterogeneous population; highly dispersed over a large geographic area; highly technologically developed; and with relatively high incomes by world standards. All of these factors conduce to the need to recognize the characteristics of individual nations as they move toward improved incomes for their populations. The key factor for the future in the US will be better utilisation of the underemployed population to abet the need for skilled workers to support a large aging dependent population, including better education, and greater mobility providing access to employment and to other social and economic opportunities. It is hoped that this assessment adds further dimension to the important challenges addressed here.

Introduction

Today we live in a challenged and challenging world. In the career of this writer, it is the most difficult period we have ever faced in which to make sound forecasts or even to make general assessments of the future. It is difficult to do transportation forecasting, of course, but more particularly it is a great challenge to understand the key drivers that impact transportation. Planning and public policy operates today in a context of serious unknowns. Among these are:

- Dramatically changing demographic attributes of the population
- An erratic and unclear economic context
- Highly volatile resource costs for almost all key inputs and uses
- Shifting technologies of transportation and other sectors
- Shifting social patterns, attitudes and values

Moreover, the time constants that influence change have themselves changed. There appears to be greater volatility in almost all patterns. There are many degrees of freedom in almost all aspects of the present context – some factors contravening, others reinforcing expected patterns. Building scenarios of the future has to be multi-dimensional.

Part of this is the product of the very difficult period the world, particularly the developed world, has been through in this century. In America, and elsewhere, sharp declines in economic activity were registered in mid-decade with a severely prolonged recovery period reaching ten years, leading many to see fundamental change rather than simply retarded recovery in the patterns since 2008. We have to continually be asking ourselves are the patterns we are seeing the product of a slow return to "traditional patterns" or is this the harbinger of "a new normal"? Each day seems to confirm that the erratic state of the world economy is the real driver of so many of these trends. The weak economy explains much and new far-reaching technology changes add to the drama and the uncertainty.

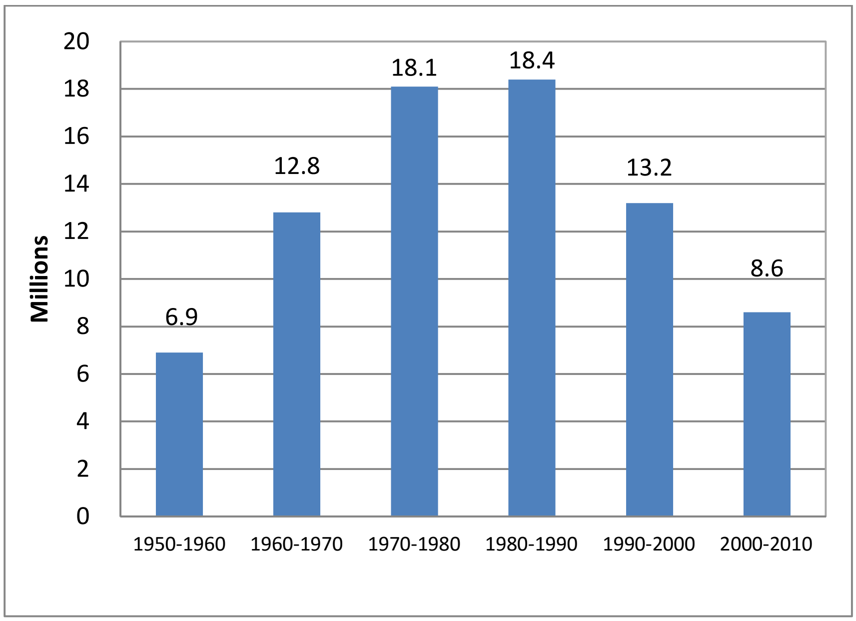
Seeking then for a tangible and consistent thread of change therefore in this time is fraught with uncertainty. This chapter will seek to differentiate those patterns that are clearest and that establish the context, the stage, on which the more uncertain patterns and speculative trends will play out.

- First, demographic trends considered to be the most stable, including projected births; labour force and employment trends, and geographic distributions, recognizing the speculative nature of trend assessments,
- Consumer spending trends and their implications for transportation and housing and their linkage to workers,
- Racial, ethnic and gender patterns will be considered, establishing a firmer base for consideration of behavioural trends;
- New technologies and their influence will be assessed;
- Finally, some public policy actions will be assessed in the context of these patterns.

The demographic challenge

The central question in this period is where will the workers come from to replace the aging baby boomer generation now reaching retirement age, and how will we support that large aging population in the future? The figure below shows that the great period of expanding numbers of workers added to the economy each decade is now behind us. It actually peaked in the eighties and has been in a steady decline since. Part of the issue in the first decade of the new century could be attributed to poor economic environment as much as a decline of persons coming of working age.

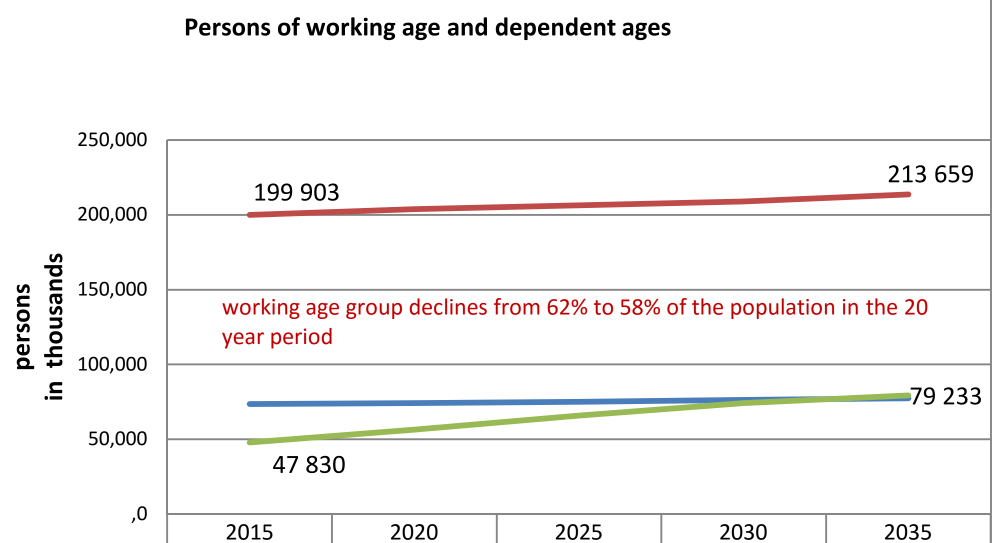
Figure 2.1. **Workers added in USA by decade.**



Source: US Census Bureau, Commuting in America 2013.

But the future does not promise any brightening in these trends. The following projections of the US Census Bureau starkly depict the gaps in the work force age group in the coming years.

Figure 2.2. **Persons of working age and dependent ages**

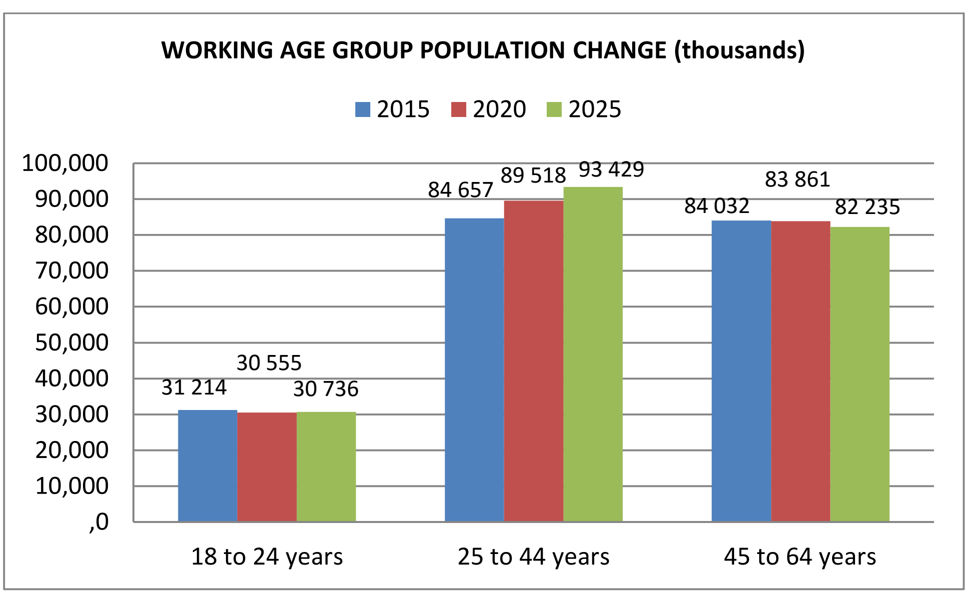


	2015	2020	2025	2030	2035
.Under 18 years	73,635	74,128	75,015	76,273	77,446
.18 to 64 years	199,903	203,934	206,400	209,022	213,659
.65 years and over	47,830	56,441	65,920	74,107	79,233

Source: US Census Bureau, Projections 2014

Examining the 18 to 64 working age group in greater detail shows that both the elder work force, those from 45 to 64 in age, and the younger work force, those in the age range of 18 to 24 actually decline in the ten year period. Whatever growth in working age population occurs is in the mid-level age group of 25 to 44.

Figure 2.3. **Working age group detail**



Source: US Census Bureau, Projections 2014

The challenges and implications are clear.

- The working age population increases by only 13.7 million and thus falls as a share of population from 62% in 2015 to 58% by 2035. This means greater numbers of dependents in the society to be supported by the working age group.

- There is an explosion in those over 65 adding over 31 million in the period, gaining 64% of the population growth arriving at over 21% of the persons in the population up from under 15% today. One effect, that is already happening, is that the over 65 population will have to continue to work.

  – In part because the economy's weaknesses have forced some to postpone retirement.

  – In part because the elder population are healthier than past generations and the nature of present work is amenable to their skills.

  – Working at home is a supporting inducement.

- Only 4 million persons under 18 are added in 20 years, which means very few coming of working or driving age.

It is important to recognize that these projections were made as the nation was coming out of the recession and may be projecting the lackluster experience of the early part of the century. However, as an example the numbers of people coming of working age in the next 10 years are already here. These projections do include expected immigration to the USA in the period. That is perhaps the number with the greatest potential for change. The table below summarizes some of the attributes of the new century. The VMT values had been in decline since 2008 and have only returned to 2008 levels in the past year.

Table 2.1. **A new century – with limited growth**

USA	2000	2015	Change	% change
Population (millions)	281.4	321.4	40	14.2%
Vehicles (millions)	221.4	260.4	39	17.6%
Road System miles* (millions)	3.936	4.177	0.241	6.1%
Lane Miles (millions)*	8.224	8.766	0.542	6.6%
Vehicle Miles of Travel (VMT) (trillions)	2.764	3.148	0.384	13.9%
VMT/ lane mile (thousands)	336	359	23	6.8%
Average Travel Time to Work (minutes)	25.5	26.0	.5	2.0%

Source: US Census Bureau; Federal Highway Administration US DOT.

More of concern, income levels in the United States as of 2014 were still well behind earlier years on an inflation-adjusted basis. The figure shows that median incomes in 2014 were below 2009 levels and all the previous years of the century. Early indications for 2015 suggest that we are close to a return to previous levels, but these data say nothing about the income distribution.

Figure 2.4. **Median household income in current and inflation-adjusted dollars**

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
CURRENT $	46,326	48,201	50,233	50,303	49,777	49,276	50,054	51,017	51,939	53,657
2014 $	56,160	56,598	57,357	55,313	54,925	53,507	52,690	52,605	52,789	53,657

Source: US Census Bureau, BLS income statistics

Counties in America

While these reduced levels of worker growth and weak incomes would seem to suggest that travel demand will weaken, or even decline, with a negative effect on infrastructure requirements, great care must be taken in assessing these trends. A large part of the question is geographic in nature with stark contrasts across the nation. The county system in the USA is utile in this assessment.

The sub-unit of government below the state in the United States is the county (some states give them different names). For statistical purposes, the Census Bureau uses counties or county equivalents as one of the basic units of statistical observation and presentation. One reason for this is that counties are highly stable and their boundaries rarely change. Beyond that geographic stability, counties are tremendously variable in size, population and economic activity. There are 3 142 counties in the United States. Some of the counties, particularly in the West, are immense in size. San Bernardino county California, the largest in the country, is larger than some states, others may be the size of small villages. The island of Manhattan is a county. Half of the population of the country lives in 146 of the counties.

Metropolitan statistical areas are aggregates of counties and therefore may contain built areas and areas that are still quite rural in character. In a recent study of national population trends[1] the stark variations by county were revealed. Broadly, between 2000 and 2010 about one third of counties lost population, just over a loss of two million; another third gained much of the national population change, just over 27 million for the decade; and the last third, all rural counties, were quite stable gaining only limited population. Therefore, many questions of economic development and sustainable population and development have very sharp variations and very different starting points in various parts of the country. Planning and policy must be sensitive to these variations and vary with the trends and changes occurring in each area.

A sample county

Fairfax County Virginia is a close-in suburb of Washington DC. It is large as counties go with a population in excess of one million and a land area of about 400 square miles, (roughly 1 000 square km) and a population of about 1 000 per square km, typical of US suburbs. It varies from very metropolitan (Tysons Corners midway between Washington DC and Dulles airport, has multiple 20 story buildings and is a greater job centre than many well-known large cities) and still there is extensive farmland in the county.

One useful way to define a suburb, which will help us understand Fairfax, is that a suburb is typically a place with more workers than jobs for them and therefore it must export workers each day. A city then can be defined as a place with more jobs than workers which must import workers each day.

In 1980, Fairfax County was a classic case of a "bedroom suburb". There were roughly 70 jobs for every resident worker. Most of the jobs were the kinds of jobs that follow households – grocery stores, department stores, car services, schools and medical services. By 2010, 30 years later, the ratio had risen to 99 jobs for every 100 workers – effectively a job worker ratio of 1. Therefore, if all the 582 000 workers filled the 574 000 jobs in the county, only 8 000 workers would need to be exported each day. This, of course did not happen, only 52% of resident workers remained to work in their home county. (This is actually a rather good ratio compared to many others.) The effect was 280 000 workers were exported each day to other jobs around the region and 272 000 workers were imported to fill the remaining jobs in the county. Therefore, 552 000 workers crossed the county boundaries each day, instead of the idealized notion of 8 000. This is really what commuting and worker access is all about.

So the concept of a balance of jobs and workers, an ideal ratio of one job per worker, answers few of the questions of connecting jobs and workers. It would be true certainly that the potential rises for some to live near work, to walk or bike to work, but modern economic structures are not necessarily that neat. It is important to examine why. But it is far more significant to understand that it is the skills mix of the jobs to be filled and those that the resident workers can provide that matters more than just simple numeric balances of jobs and workers.

- Perhaps the key reality of work – home relationships in America and other countries, as well, is that about two-thirds of workers live in a household where there are multiple workers. The question then, if living near work is a goal, whose job will they live near? It is possible, but not likely, that they will both, or all, find local work that matches their disparate skills, economic needs and career objectives.

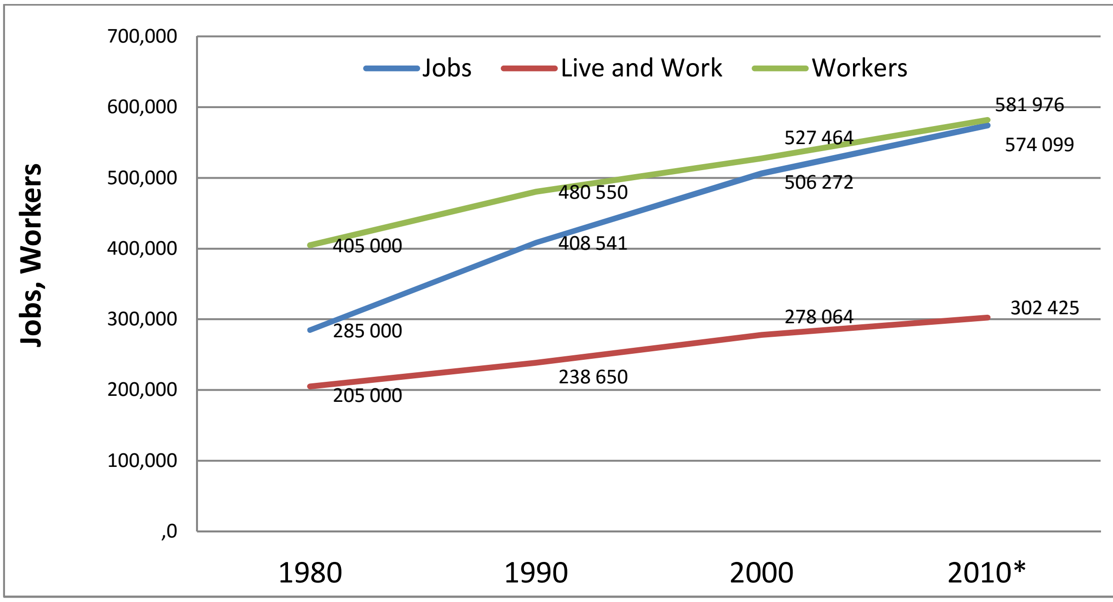
- When one person in the household changes jobs (especially among young workers – job changes occur every two or three years), will they uproot and move each time, especially when the prospect of moving again soon is clear? There is a clear expense and mental dislocation associated with moving – doctors, favourite stores, friends, etc.

- One of the reasons that large metro areas are attractive to workers, and employers, is the array of choices of jobs (or workers), say, within a half-hours travel there. Particularly, recognizing the growing specialization of skills in job requirements or in workers the catchment areas for persons with the requisite skills must expand to assure adequate choices of skilled workers.

- Growing specialization in skills seems to be an assured complement of changing work force requirements now and into the future. Employers reaching out farther and farther to find the skills they require will be a natural outcome of this trend.

- Moreover, we must recognize that optimizing the commute trip is not necessarily very high on many household's preferences. Often a considerable commute distance is a price people willingly pay to retain a preferred environment for their families – schools, amenities – which makes the commute an acceptable trade-off. The basis for changing homes is a complex one discussed more fully later.

Figure 2.5. **Fairfax County Virginia – 1980-2010**



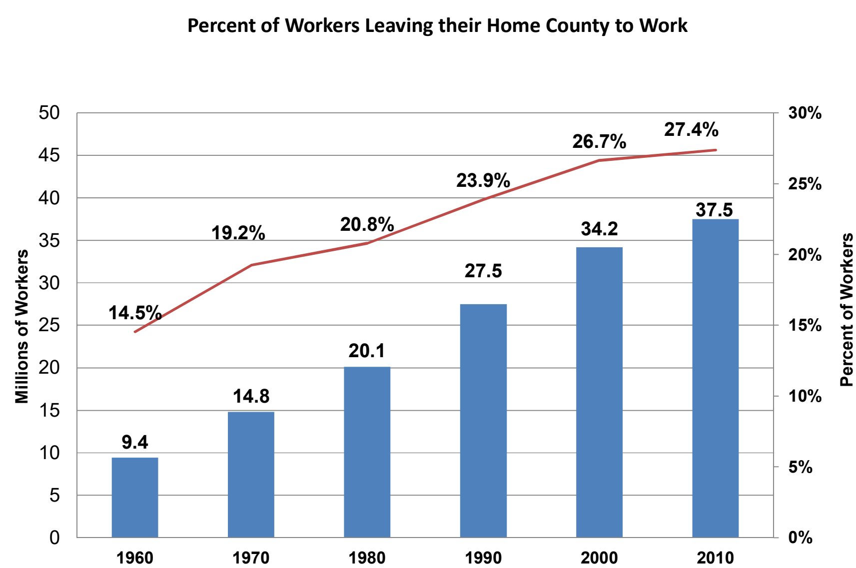
Source: US Census Bureau, Commuting in America 2013

Finally, it is to be observed that by 2013 our case study area, Fairfax County Virginia, actually had reached a stage where it had more jobs than workers, a job/worker ratio of 1.04, completing the transmutation from a bedroom community to a job centre. In that three years from the census of 2010 there was an increase in 30 000 residents who both lived and worked in the county with the percentage rising to 54% contrasted to 52% in 2010, and still there were now 571 000 workers, both exports and imports, crossing the borders of the county each day.

This is a trend that can be perceived around the country as suburban residence communities gain jobs and central cities gain residents so that both types of areas are moving closer to job/worker ratios of 1 from opposite directions but still generating extensive travel between areas. The impacts on the less skilled workers need to be carefully assessed. In some areas as employers move to be near the skilled workers they need, the effect is to raise costs in neighbourhoods and push the lower income workers farther away from some job sites. In the end, it may be the lower income workers with the greater commuting requirements. The dominant commuting pattern today in the USA is from suburb to suburb rather than focused on the centre creating very mixed patterns of flow.

A key statistic, that presents this trend in its national scope, is that since 1960 the number of workers working in a county different from their residence county has grown astoundingly, as both housing and jobs have relocated. The number of workers traveling outside their home county quadrupled from 9.4 million in 1960 to 37.5 million in 2010, a shift from 14.5% to 27.4% of all commuters. By 2014, that number had risen to over 40 million workers. Thus, the Fairfax county Virginia story is being told repeatedly throughout America.

Figure 2.6. **Percent of workers leaving their home county to work**



Source: US Census Bureau, Commuting in America 2013

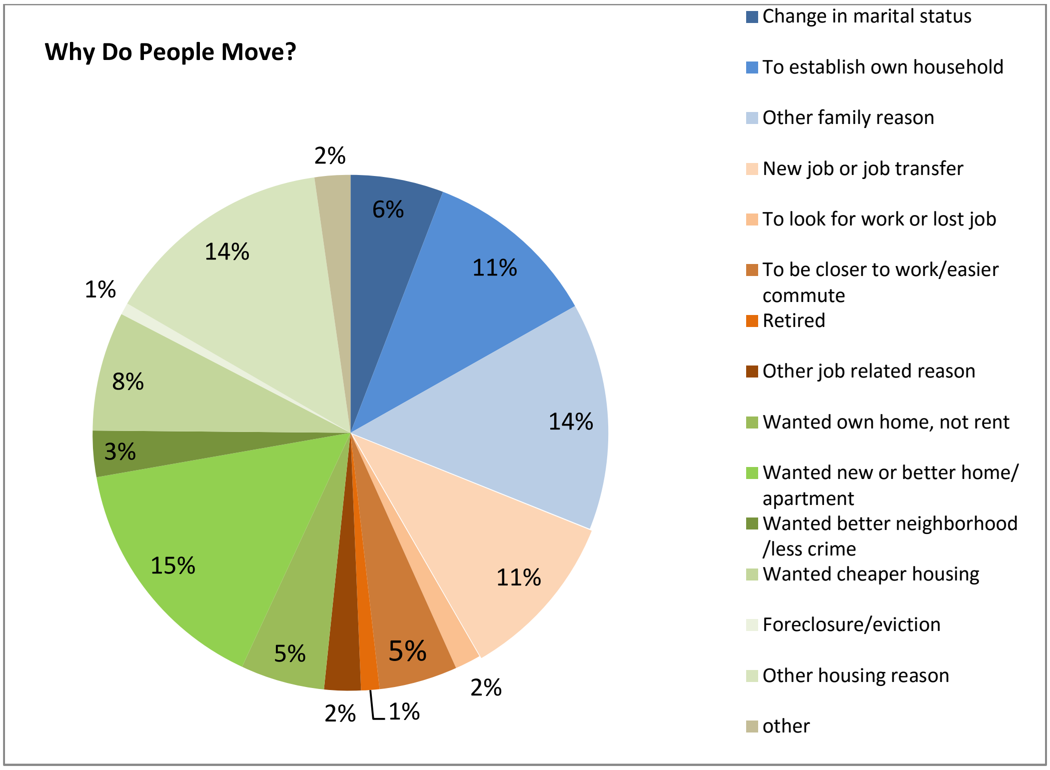
Of interest is that the share of transit users rises sharply with shifts away from the residence county. Among the 7.6 million transit users in 2014 only 4.4 million, about 58%, used transit to travel to work within their residence county, meaning that 42% of all transit users leave their home county to work, and while transit users represent only 5.2% of all commuters they represent almost 8% of workers crossing county boundaries. Thus, while transit is often seen as the complement to a compact city the lengths of transit lines often support extensive population dispersion and long distance job connections to workers, even including inter-metropolitan workflows.

Redistribution of population and workers

Of the 312 million people in the US in the period of study, fewer than 12% moved between 2014 and 2015, and of these the great majority simply moved elsewhere within their residence county, generally for reasons related to housing preferences. Only about 4% of the population moved to a new county, most often to a different county within the same state. A slightly larger share of movers is unemployed, and they tend to be willing to move farther presumably in job searches. So worker mobility seems strong where job search is concerned, particularly among the younger population.

There are three broad categories of why people move: the first is changes in family structure, marriage or other changes, 31%; changes in job situations, 21%; and changes in the housing itself, 46%.

Figure 2.7. **Why do people move?**



Source: US Census Bureau, Census table 17-1, Geographic Mobility 2014-2015.

One of the effects of the prolonged recession recovery was that it suppressed moving as persons could not afford new housing or could not sell their present homes, or perhaps were afraid to leave jobs for fear of lack of alternatives. It is in the nature of an economic recession that it locks people into their homes and jobs if only due to the uncertainty generated by trends. Current data indicate the beginnings of a return to more normal levels of geographic mobility. One of the great strengths of America has been a totally open market for jobs so that workers from any state can respond to job opportunities anywhere in the country. The recent shifts of oil field workers to remote areas such as North Dakota and West Texas are a good example of that flexibility. There are few language barriers or other social or governmental barriers to impede worker flows across states and counties. This is a strong positive in national workforce balances for both skilled and unskilled labour. Among the strongest growth in occupations will be in the health related fields, serving, in many cases, the elderly population. Both skilled professionals and less skilled technicians and support personnel will move to where the elder populations choose to locate.

As can be seen from the chart, about 20-21% of movers give work-related reasons for their move including job transfers, looking for work or retirements. Overall, only about 5% of movers identify wanting to improve their commute situation as a reason for moving. It can be assumed, however, that many others would be delighted to see their travel to work be less time consuming, less expensive and less stressful, but accept it at the present time as the trade they make between the job and housing they want. Comparatively, US commute times and congestion issues are relatively benign by world standards.

Consumer expenditures and the housing/transportation nexus

The Consumer Expenditure Survey, CEX, managed by the US Bureau of Labour Statistics, BLS, is the source of the national measures of the cost of living index. It carefully records all outlays by "consumer units"[2] relatively close in definition to the typical sense of a household. The power of this survey is that it details expenditures for a complete array of categories and a comprehensive set of demographic attributes. The HBS, Household Budget Survey of Eurostat is similar in function. A limited set of these tables, focused on quintiles of income and geography, will be employed here.

Table 2.2. **2014 Consumer Expenditure Survey Demography**

Average number in consumer unit:	**All consumer units**	**Lowest 20 percent**	**Second 20 percent**	**Third 20 percent**	**Fourth 20 percent**	**Highest 20 percent**
People	2.5	1.7	2.2	2.5	2.8	3.2
Children under 18	.6	.4	.5	.6	.7	.8
Adults 65 and older	.4	.4	.5	.4	.3	.2
Earners	1.3	.5	.8	1.3	1.7	2.1
Vehicles	1.9	.9	1.4	1.9	2.3	2.8
Annual Expenditures	USD 53 495	USD 23 713	USD 33 546	USD 45 395	USD 60 417	USD 104 363

Source: US Bureau of Labor Statistics, Consumer Expenditure Survey BLS 2014

Table 2.3. **2000 Consumer Expenditure Survey Demography**

Average number in consumer unit:	**All consumer units**	**Lowest 20 percent**	**Second 20 percent**	**Third 20 percent**	**Fourth 20 percent**	**Highest 20 percent**
People	2.5	1.8	2.3	2.5	2.8	3.2
Children under 18	0.7	0.4	0.6	0.7	0.8	0.9
Adults 65 and older	0.3	0.4	0.5	0.3	0.2	0.1
Earners	1.4	0.7	1	1.4	1.7	2.1
Vehicles	1.9	1	1.5	1.9	2.4	2.9
Annual Expenditures	USD 38 045	USD 17 940	USD 26 550	USD 34 716	USD 46 794	USD 75 102

Source: US Bureau of Labor Statistics, Consumer Expenditure Survey BLS 2014

There were about 25 million consumer units per quintile in 2014, and about 16.3 million in 2000. Rather than examine spending against CU incomes, it is more effective to scale them against quintile expenditures, particularly because in lower income groups older and younger people spend above their incomes as a result of other sources of spending such as savings among older persons or family support in the case of young students.

Comparing 2000 and 2014

The differences are surprisingly slight between two periods 15 years apart. The key differences are:

- People: the two lower income quintiles have grown slightly smaller, others are the same
- Children under 18: in each quintile, except the lowest, there were more children in 2000
- Adults over 65: there are more persons over 65 particularly in the higher income quintiles in 2014
- Earners: there are fewer earners in the three lowest quintiles; the number is constant in the top two
- Vehicles: vehicle ownership was slightly higher in almost all quintiles

To assess income inequality trends the ratios of highest to lowest quintile for each period is as follows:

Table 2.4. **Ratio of highest to lowest quintile elements**

	2000	2014
People	1.8	1.9
Children under 18	2.3	2.0
Adults 65 and older	0.3	0.5
Earners	3.0	4.2
Vehicles	2.9	3.1
Annual expenditures	4.2	4.4

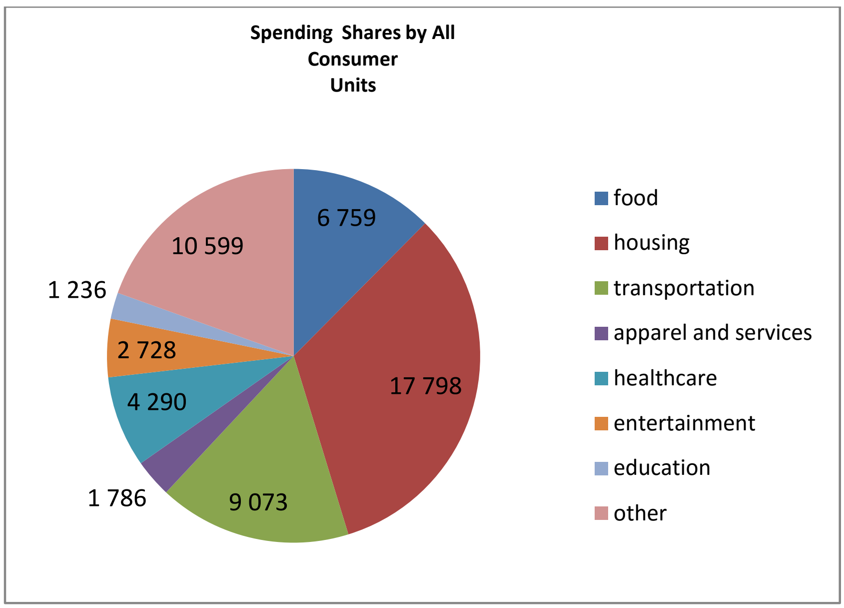
Source: Calculation by author from US Census Bureau BLS data in tables 2.2 and 2.3 above.

There are significant changes here. The ratio of populations is up slightly; children under 18 shows a sharp decline; adults over 65 increased substantially; but most significant is that the earner ratio jumped sharply, entirely as a function of the decline in workers in the lowest quintile. Both vehicle ratios and spending ratios increased.

In assessing the population in the lowest quintile of income and their expenditures in 2014, there are many suggestive factors to consider. Some are soundly based in statistics, others more speculative. Overall, they do not permit a definitive picture to emerge. The first statistic to consider is that the average expenditures of just under USD 24 000 in the lowest quintile are more than double the reported mean income for the group of USD 10 750. Note that only 0.5 workers per household are reported, indicating the presence of either high unemployment, high levels of retired persons, or possibly college students in the group. With a relatively high share of persons over 65 and with over 60% of respondents being women, a sense can emerge of a high proportion of this quintile's population consisting of retirees, particularly women, whose spending may be distinct from their incomes. At the same time the group registers 50% college graduates, 39% homeownership and 63% with at least one vehicle, and at 1.8 the highest ratio of vehicles per worker of all quintiles. It is possible that other members of this cohort can be college students functioning as consumer units, registering limited incomes but with support from parents or others. Finally, a third group is suggested by the fact that while African-Americans comprise only 13% of the US population they constitute 21% of this quintile. Clearly, the statistical picture of this quintile transmits a very mixed image.

The trends are important here; both percent home ownership and possession of at least one vehicle declined from 2000 to 2014: from 43% to 39% for home ownership; and from 66% to 63% with at least one vehicle. What did rise was college degrees; from 39% in 2000 to 50% in 2014. There also was a significant rise in the African-American share from 17% to 21%.

Figure 2.8. **Spending shares by all consumer units**



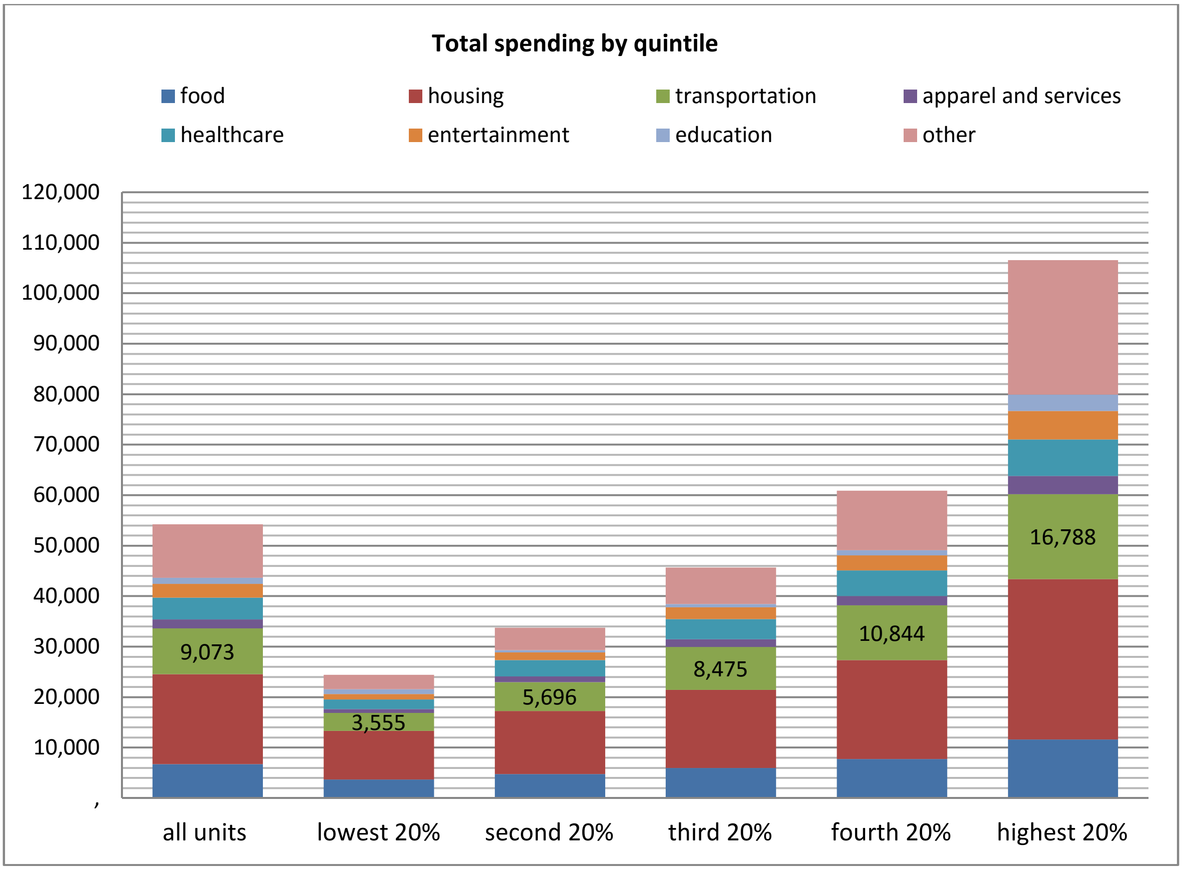
Source: US Bureau of Labor Statistics, Consumer Expenditure Survey BLS 2014.

Aside from their incomes there are important quintile attributes revealed in the ranges from lowest to highest quintile in the 2014 summary descriptive table:

- The number of persons in the CU's rises with income from 1.7 to 3.2.
- The number of children doubles from 0.4 to 0.8 per CU.
- The number of elders halves from 0.4 to 0.2.
- The number of vehicles owned triples from 0.9 to 2.8.
- Most significantly, the number of earners per CU more than quadruples from 0.5 to 2.1.
- The ratio of earners is roughly in proportion to the ratio of expenditures.

These attributes go far in explaining the significant differences in expenditures, where stage in the life cycle as demonstrated here, may be as pertinent as incomes.

Figure 2.9. **Total spending by quintile**



Note: Other is largely contributions to insurance, pensions and social security

Source: US Bureau of Labor Statistics, Consumer Expenditure Survey BLS 2014.

Table 2.5. **Spending in major categories by highest and lowest quintiles**

	2000			2014		
Main Expenditure	Lowest Quintile	Highest Quintile	Ratio	Lowest Quintile	Highest Quintile	Ratio
Food	2,673	8,679	3.25	3,667	11,595	3.16
Housing	6,509	22,611	3.47	9,643	31,812	3.30
Apparel	844	3,989	4.73	786	3,625	4.61
Transportation	3,212	13,315	4.15	3,555	16,788	4.72
Health	1,470	2,864	1.95	1,868	7,219	3.86
Entertainment	837	3,866	4.62	1,108	5,629	5.08
Other	2,395	19,778	8.26	2,909	26,646	9.16
Total	17,940	75,102	4.19	23,713	104,363	4.40

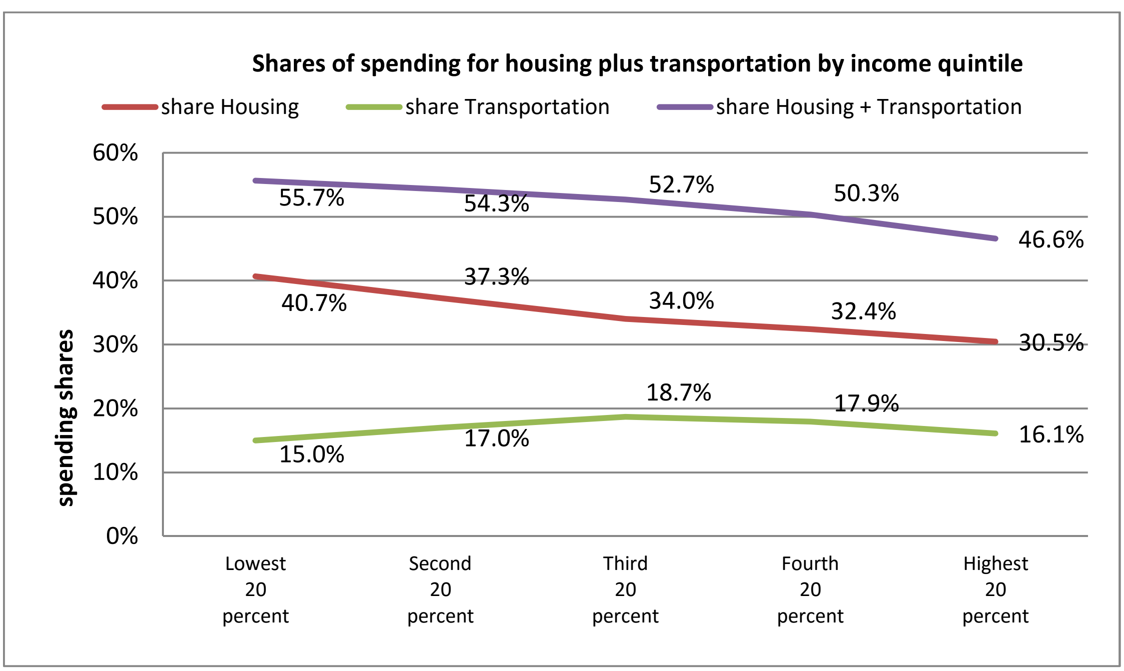
Source: US Bureau of Labor Statistics, Consumer Expenditure Survey, BLS 2000 and 2014

Overall spending in 2014 by all units is above USD 53 000; the lowest quintile's spending is at USD 23 700 and the highest at USD 104 000 for a ratio of highest to lowest of 4.4. Table 2.5 identifies the highest/lowest ratios for the main expenditure categories in 2014 and, for comparison, for the year 2000 also. The overall expenditure ratio has risen from 4.19, at the turn of the century, to 4.40 in 2014 indicating a growing disparity in spending between quintiles. Of greater pertinence is that transportation is the only basic expenditure where the ratio increased between the periods, in all other basics the ratios declined. The category of "Other" also showed an increase; this category largely consists of savings, insurance, payments to pensions and social security. We can note that health trends showed a large rise; this is largely a product of changes in the data collection design regarding health care that shifted some categories and obtained improved information.

The transportation-housing trade-off

In the housing-transportation expenditure combination there is a real trade-off at work. In the lower income quintiles, the sum of transportation and housing is above 50%. As incomes increase, the shares decline to below 50%. In this trend housing declines as a share of spending while transportation rises slowly with income and then tapers off in percentage terms at the highest levels. This is reflected as well in city vs. rural trade-offs and some other factors. Transportation is the only one of the major expenditure categories where spending shares rise as incomes rise indicating that there is real value in transportation that consumers pursue greatly as incomes rise. As noted above the decline in transportation spending as a share of total expenditures does not suggest that transportation spending does not rise. It jumps dramatically, as the figure above shows, reaching spending levels of almost USD 17 000 in the highest quintile. Much of this expansion is related to purchases of new vehicles and expanded air travel.

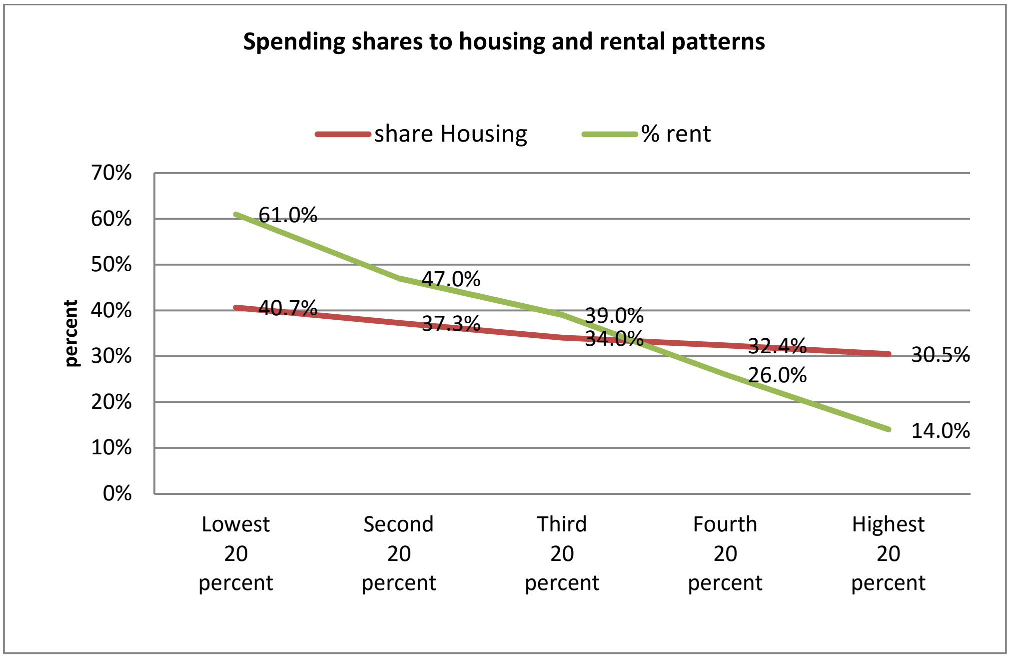
Figure 2.10. **Shares of spending for housing plus transportation by income quintile**



Source: US Bureau of Labor Statistics, Consumer Expenditure Survey BLS 2014

One of the key factors is the own vs. rent trade-off. The figure below shows that rentals decline sharply with rising incomes while at the same time spending shares for housing also decline. This trade-off will be addressed further below.

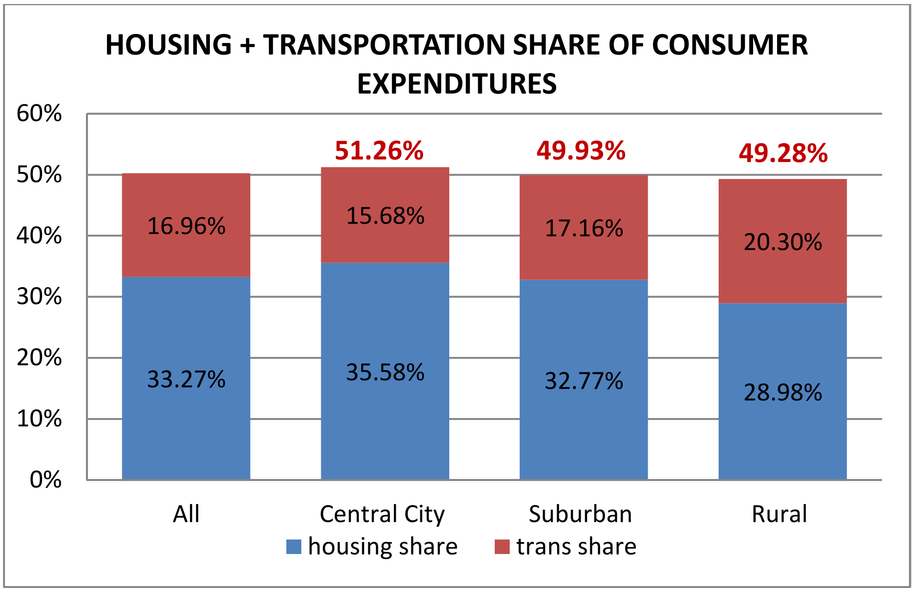
Figure 2.11. **Spending shares to housing and rental patterns**



Source: US Bureau of Labor Statistics, Consumer Expenditure Survey BLS 2014

Rather than focusing on quintile trade-offs based on incomes, the best mechanism to understand the inherent housing-transportation trade-off is in geographic structure. The figure below shows that transportation rises as a share of spending in rural areas vs. central cities, even exhibiting greater absolute spending in rural areas, despite the fact that incomes are considerably lower than centre city incomes. But the greater spending on transportation is more than compensated for by declines in housing costs with the result that rural total spending per CU is below 50% whereas central city spending with its much lower transportation spending cannot overcome higher housing costs so total spending is well above 51%. Suburban spending is at the average of almost exactly 50%. The percentage differences are modest but have tended to be stable over time.

Figure 2.12. **Housing plus transport share of consumer expenditures**



Source: US Bureau of Labor Statistics, Consumer Expenditure Survey BLS 2014

Perhaps the key point here is that home ownership rises as shares of spending declines. Urban residents, despite spending almost 36% of their expenditures on housing, have home ownership levels of only 47%, which rises to 68% in suburbs and 79% in rural areas, both with significantly lower shares of spending.

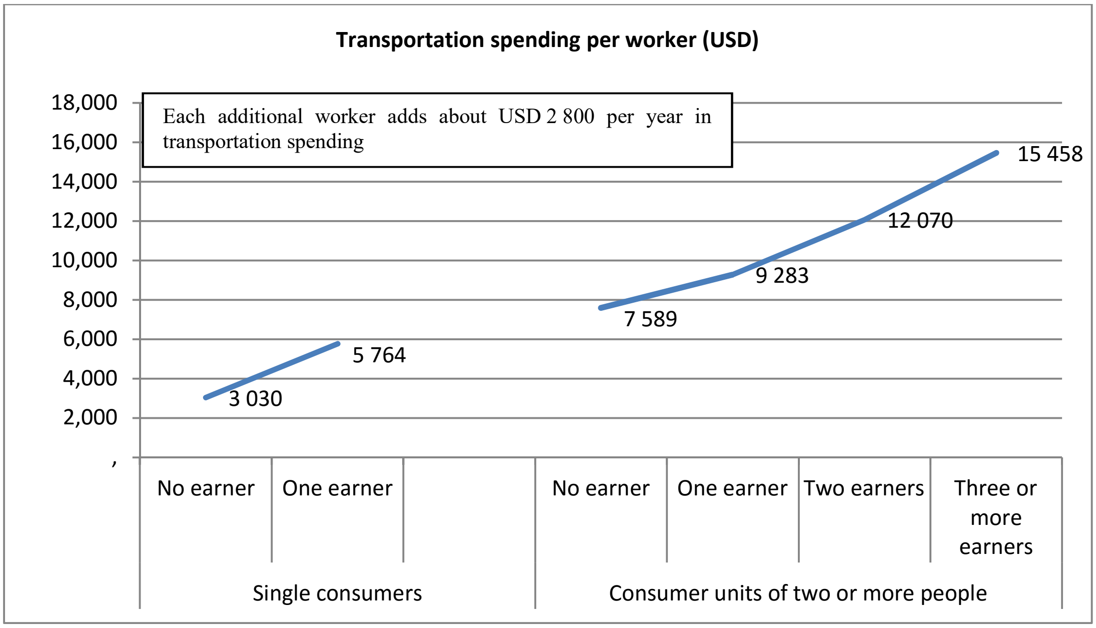
Thus, the rural resident's payment of higher shares of expenditure for transportation is compensated by more than equivalent declines in housing cost shares and with rising home ownership. And despite their lower incomes, rural residents have an average ownership of 2.4 vehicles contrasted to the centre city level of 1.4. In rural areas, many of those vehicles may have work functions. Interestingly both segments of the population have the same average number of 1.2 workers per CU but central city earners have incomes after taxes of almost USD 52 000 well above the USD 46 500 in rural areas.

In short then, it may devolve into a life-style question where preferences for renting vs. owning, large lots versus smaller space, preferences for greater access to walking opportunities vs. longer commute times are worked out.

Transportation spending and the worker linkage

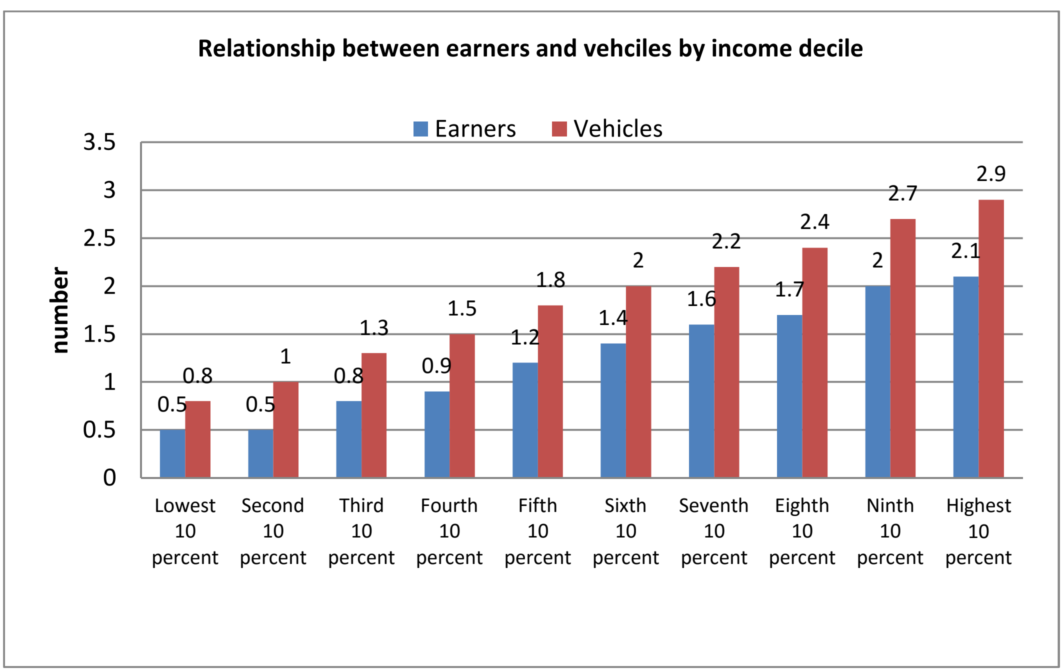
One of the keys to understanding transportation spending in the US is through study of workers. The figure explains the relationships. It shows that single consumers, where the consumer does not work, spend about USD 3 000 a year for transportation; if that single consumer works it rises to about USD 5 800. If the consumer unit has multiple members with no workers they spend about USD 7 600 per year on transportation, about proportional to the single non-worker, on a per person basis. This value has risen lately with increases in CU's with multi-person retirees. But transportation spending increases with each additional worker. In both the single consumer and multiple consumer units the increase per additional worker is about USD 2 800 per year reaching household spending of USD 15 500 per year in households with three or more workers. It is only in the category of three or more earners that vehicles owned do not exceed the number of workers.

Figure 2.13. **Transportation spending per worker (USD)**



Source: US Bureau of Labor Statistics, Consumer Expenditure Survey BLS 2014

Figure 2.14. **Relationship between earners and vehicles by income decile**



Source: US Bureau of Labor Statistics, Consumer Expenditure Survey BLS 2014

A major point here is that at almost every level vehicles exceed the number of workers in households. The foregoing figure for the complete set of income deciles illustrates that point. The historical worker-vehicle linkage is changing, largely because of the rapid retirement trends today.

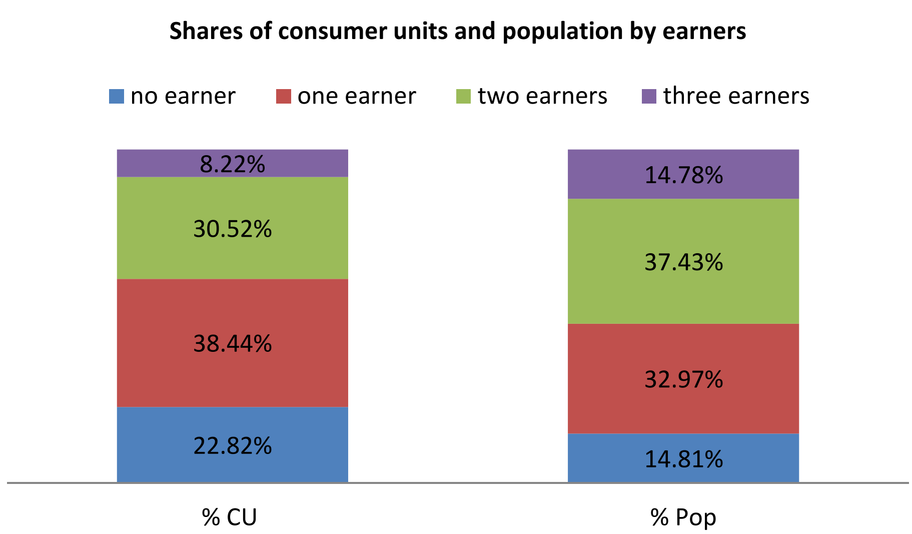
An important characteristic of the new American demography is that there are already 29 million CU's with no workers in them, 46 million people, largely thru retirement but also job displacement, indicating sharp declines in transportation spending. The historical national range for transportation spending as a share of spending is about 18%. Note that in the multiple person CU's that home ownership, vehicle ownership and persons over 65 are all higher than those of single person CU's.

Table 2.6. **Consumer Units without workers**

	Single person CU	Multi-person CU
Consumer Units (000's)	15 880	13 107
persons/CU	1	2.3
persons (000's)	15 880	30,146
One or more Vehicles	65%	86%
Persons > 65	0.6	1.3
% female	61%	53%
% homeowners	57%	75%
Trans. spending	USD 3 030	USD 7 589
All spending	USD 25 565	USD 43 418
Trans. share	11.9%	17.5%

Source: US Bureau of Labor Statistics, Consumer Expenditure Survey BLS 2014

Figure 2.15. **Shares of Consumer Units and population by earners**

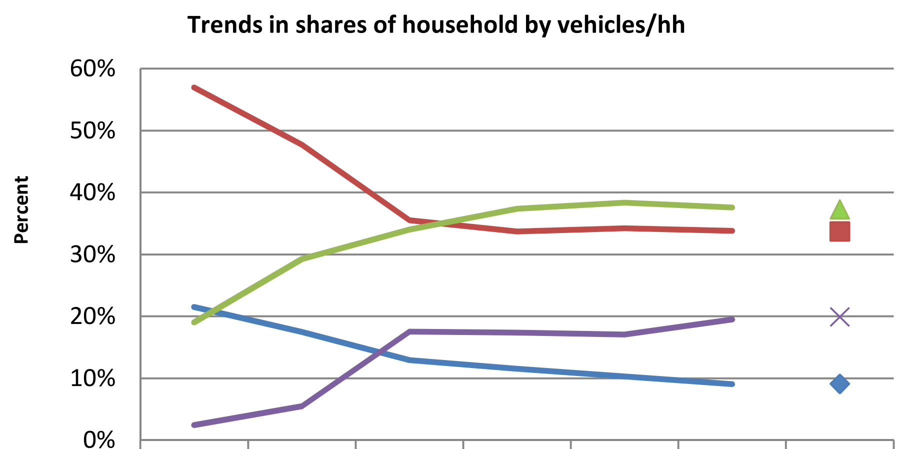


Source: US Bureau of Labor Statistics, Consumer Expenditure Survey BLS 2014

Vehicle ownership patterns and social equity

The figure below depicts the shares of households by the number of vehicles owned. Most notable is that the trend has been relatively stable since the 1980's, with only small shifts in shares over the 30+ year trend. This can be labelled close to vehicle saturation. Perhaps most significant is that households without vehicles has reached about a 10%-9% share since 1990. The actual number of households without vehicles has varied only slightly in a range of from 11 to 10 million over more than a 50-year period, but declining sharply in share as the number of households expanded. Moreover, the majority of those zero vehicle households are households without workers, either retired or young unemployed. Only 4.5% of workers live in households without vehicles indicating the vast majority of workers have access to a vehicle for work travel.

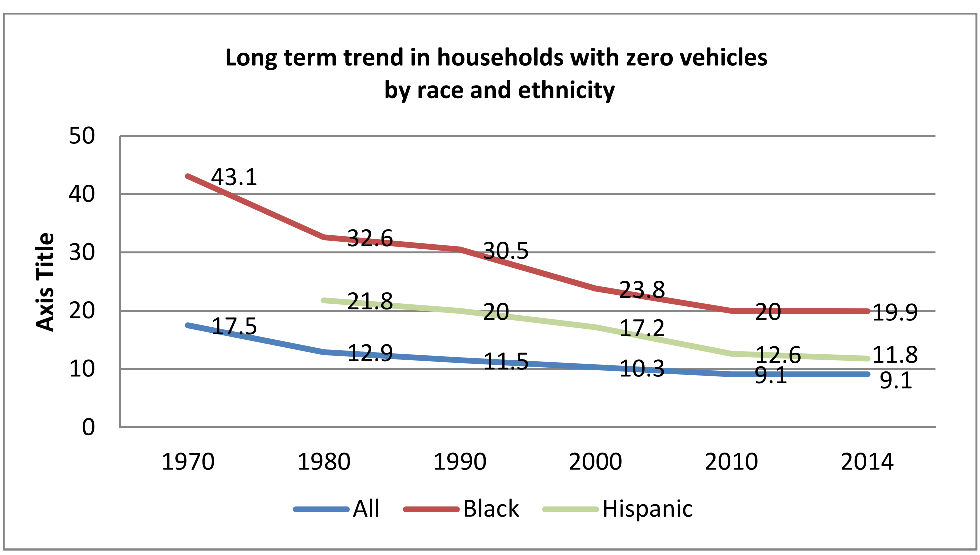
Figure 2.16. **Trends in shares of households by vehicle/hh**



	1960	1970	1980	1990	2000	2010	2014
O VEHICLES	21.5%	17.5%	12.9%	11.5%	10.3%	9.1%	9.1%
1 VEHICLE	57.0%	47.7%	35.5%	33.7%	34.2%	33.8%	33.7%
2 VEHICLES	19.1%	29.3%	34.0%	37.4%	38.4%	37.6%	37.3%
3 + VEHICLES	2.5%	5.5%	17.5%	17.4%	17.1%	19.5%	19.9%

Source: US Census Bureau, US decennial Census and American Community Survey 2014

Figure 2.17. **Long term trend in households with zero vehicles by race and ethnicity**



Source: US Census Bureau, US decennial Census and American Community Survey 2014

Growing homogeneity in travel behavior

The above figure makes an important contribution to the relevance of a growing homogeneity in many aspects of travel in the US. The most remarkable attribute of the figure is that African-American household vehicle ownership has changed dramatically in the period. In 1970, 43% of black households had no vehicles; today that level has reached below 20%. A parallel pattern is exhibited by Hispanics; from just below 22% in 1980 to under 12% today. While this is a broadly positive trend two factors are clear: there is still a distance to go, especially for African-American households to reach comparability in household attributes; and the recession has slowed but not stopped the trend.

Mode choice trends, at least in the work trip, have also become more homogeneous.

Table 2.7. **Trends in mode to work by race and ethnicity**

Drive alone	2000	2010
Hispanic	60.60%	67.80%
African-American	67%	72%
Total Pop.	75.70%	76.50%
Carpool		
Hispanic	22.70%	16%
African-American	16%	10%
Total Pop.	12.20%	9.70%
Transit		
Hispanic	8.60%	7.80%
African-American	12%	10.90%
Total Pop.	4.60%	4.90%

Source: US Census Bureau, Commuting in America 2013

The table demonstrates a closing of gaps between the national patterns and those of African-Americans and Hispanics. The African-American population has long been the highest users of transit, and Hispanics, while also using transit more than average, were most notable as mainstays of car-pooling, owing to the nature of work often among the Hispanic population.

It is important, therefore, to see that car-pooling in both Hispanic and African-American population is shifting sharply toward the national norm. A similar pattern is visible in transit usage. The effect of this is to increase the shares in both groups of driving alone to work- the percentage changes were dramatic. These data, generated by the Census Bureau, only cover work travel. The new National Household Travel Survey, last conducted by US DOT in 2009, and now in the field collecting new data will tell us more about whether these shifting trends extend to other trip purposes as well, when available in 2017-2018.

In a somewhat parallel fashion, gender differences are becoming more homogeneous as well based on work travel data. Historically, women's work travel patterns were significantly different from men's; in trip distance, in time of travel and mode choice. Many of these factors were consistent with the gender roles of the time. Fewer drivers' licenses, less access to vehicles, jobs closer to home, etc. were part of the pattern. As women's work roles became more like men's so has their travel behavior. The female/male ratios in most travel were sharply skewed. Today, all differences are closing in just about every mode of travel. Most surprising is that Driving Alone to work is now a predominantly female pattern. In 1990, women's driving alone was in a ratio of 97% of men's. It has now surpassed men at 101%. All other modes similarly have moved in the direction of homogeneity. Carpooling and transit use ratios have moved closer to 1:1. Previously women walked to work more than men did; now it is less. The only areas where strong differences remain are in long distance commuter rail travel, bicycling, and motorcycling, but even there the vast differences are closing somewhat.

Table 2.8. **Modal shares to work by gender**

	Male	Female	F/M ratio
Car, truck, or van	86.07%	86.47%	100.5
Drove alone	76.19%	77.00%	101.1
Carpooled	9.88%	9.47%	95.9
In 2-person carpool	7.51%	7.52%	100.2
In 3-person carpool	1.32%	1.21%	91.9
In 4-or-more-person carpool	1.05%	0.74%	70.3
Public transportation	4.63%	5.29%	114.4
Bus or trolley bus	2.34%	2.95%	126.4
Streetcar or trolley car	0.06%	0.07%	120.1
Subway or elevated	1.62%	1.78%	109.6
Railroad	0.58%	0.47%	80.8
Ferryboat	0.03%	0.02%	72.8
Bicycle	0.75%	0.30%	39.7
Walked	2.85%	2.68%	94.1
Taxicab, motorcycle, other	1.44%	0.86%	59.4
Worked at home	4.26%	4.40%	103.1

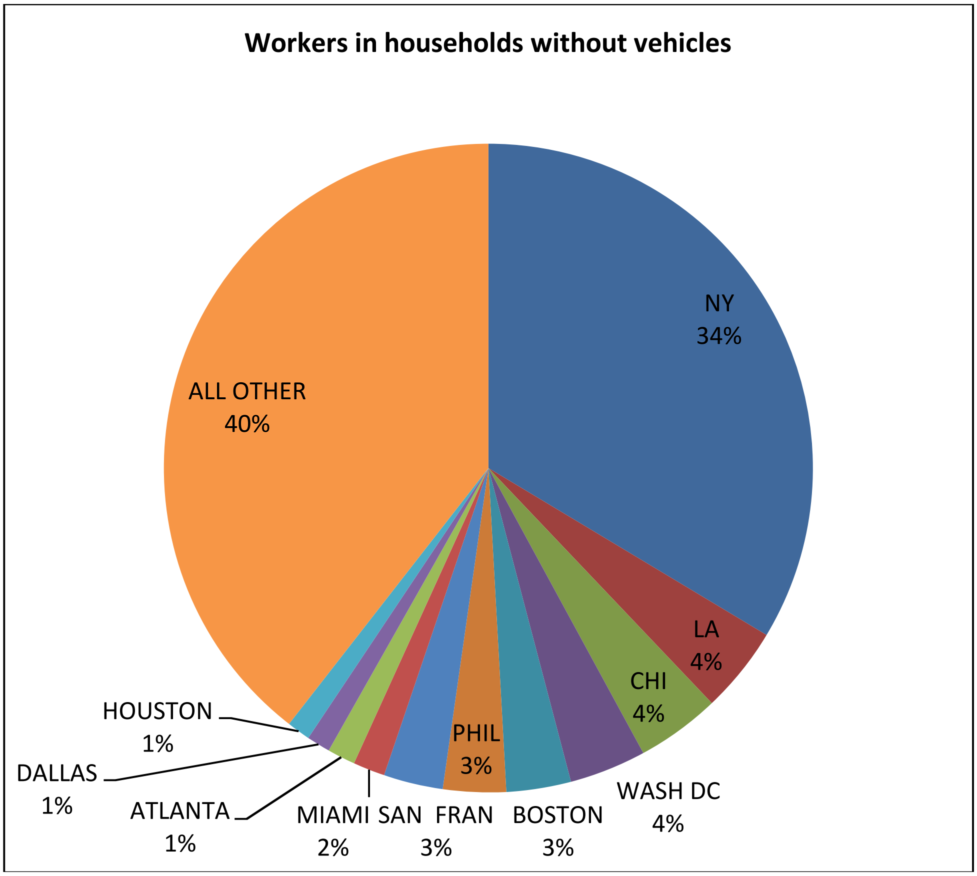
Source: US Census Bureau, Commuting in America 2013

None of this is to suggest that some modes are preferable and more women driving alone to work is a more desirable social outcome but it does argue that race, ethnicity and gender differences in travel are diminishing and their explanatory power in understanding travel behavior is less powerful. In the future, it is clearer that factors such as age, education, occupation, geographic location and incomes will be the main factors of behavior differences.

Where are the zero vehicle households?

There are 10.7 million households in America without a vehicle. However, many of these households consist of single retirees, the majority of which are women who do not have licenses. There are only 6.5 million workers who live in zero vehicle households. Of these, about one-third, 2.2 million, live in the greater New York metropolitan area. The remainder are distributed among the top ten metros as shown in the figure and with a remainder of 40% distributed in smaller metros, small towns and rural areas of the country.

Figure 2.18. **Workers in households without vehicles**



Source: US Census Bureau ACS 2014

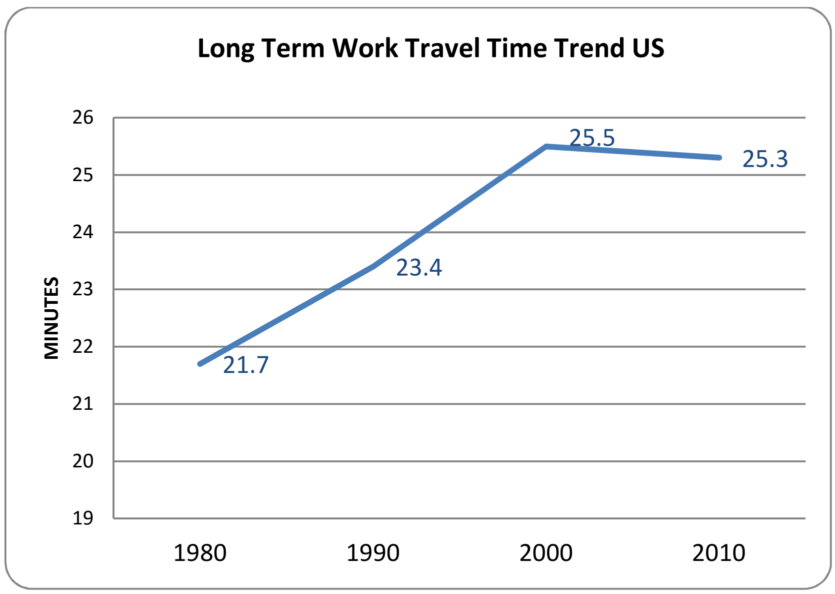
Travel times, mode use and access

It was not so long ago that the majority of American workers reached work in less than 20 minutes. As of 2014, the following pattern existed:

- Of the 146 million workers in the US in 2014, 6.5 million worked at home, therefore with a remainder of just over 139 million who left home to work.
- Of those, 19 million were at work in 10 minutes or less;
- 20 million were at work within 10 to 14 minutes;
- And 22.5 million reached work within 15 to 19 minutes
- In total over 61 million were at work in less than 20 minutes and if those who work at home are included, then very close to 68 million were at work in less than 20 minutes, representing 47% of the work population.
- The trend in average travel times over time are shown in the figure below.

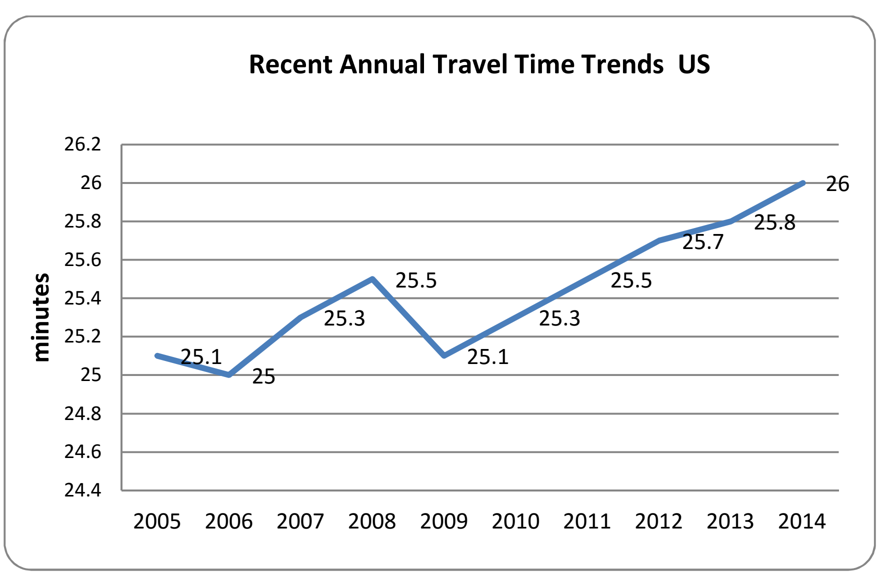
America has had a very stable period in which travel times were effectively constant, largely due to 9/11 and the more recent recession, which reduced work travel, especially in that job losses were heaviest in construction and in manufacturing, which frequently involve long distance, carpool trip making. Between 2000 and 2009, average travel times remained constant at 25.5 minutes. As the job recovery began after 2008, travel times slowly increased to the level of 26 minutes as of 2014 – that is a gain of a half a minute in this century. The two travel time figures represent two different surveys of the Census Bureau – the decennial conducted each decade and now the American Community Survey, ACS, which began as an annual survey in 2005. Their designs are structured to carry forward constant comparable measurements.

Figure 2.19. **Long term work travel time trend US**



Source: US Census Bureau, US Decennial Census

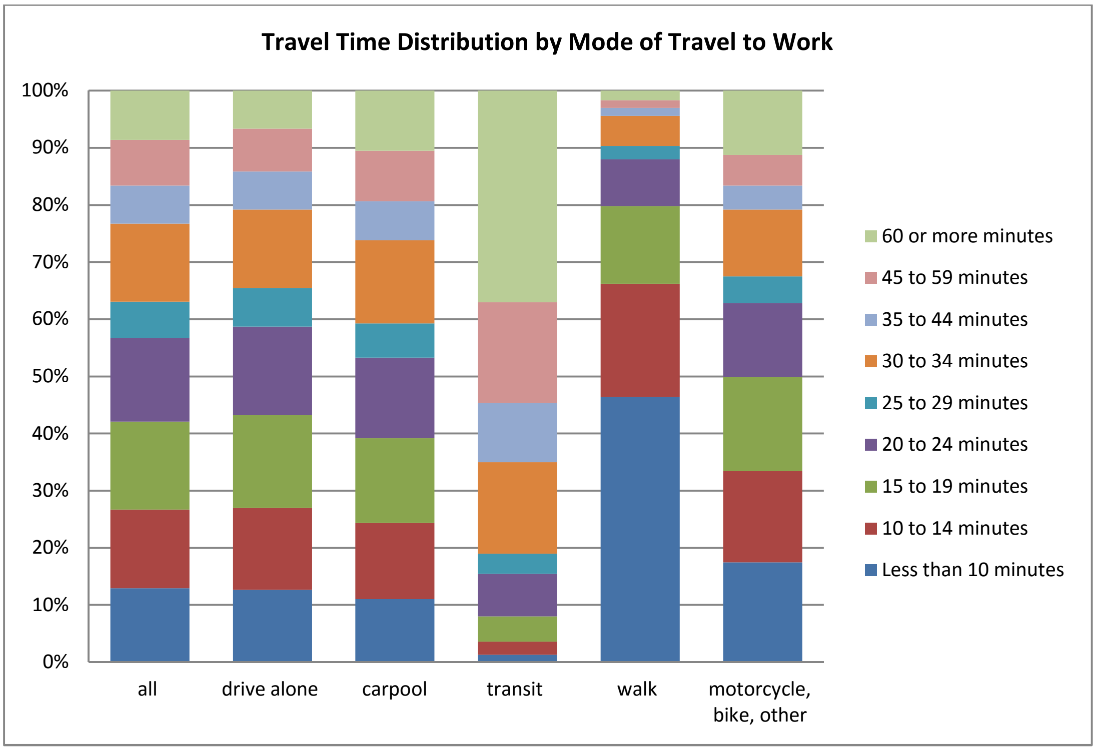
Figure 2.20. **Recent annual travel time trend US**



Source: US Census Bureau, American Community Survey annual series

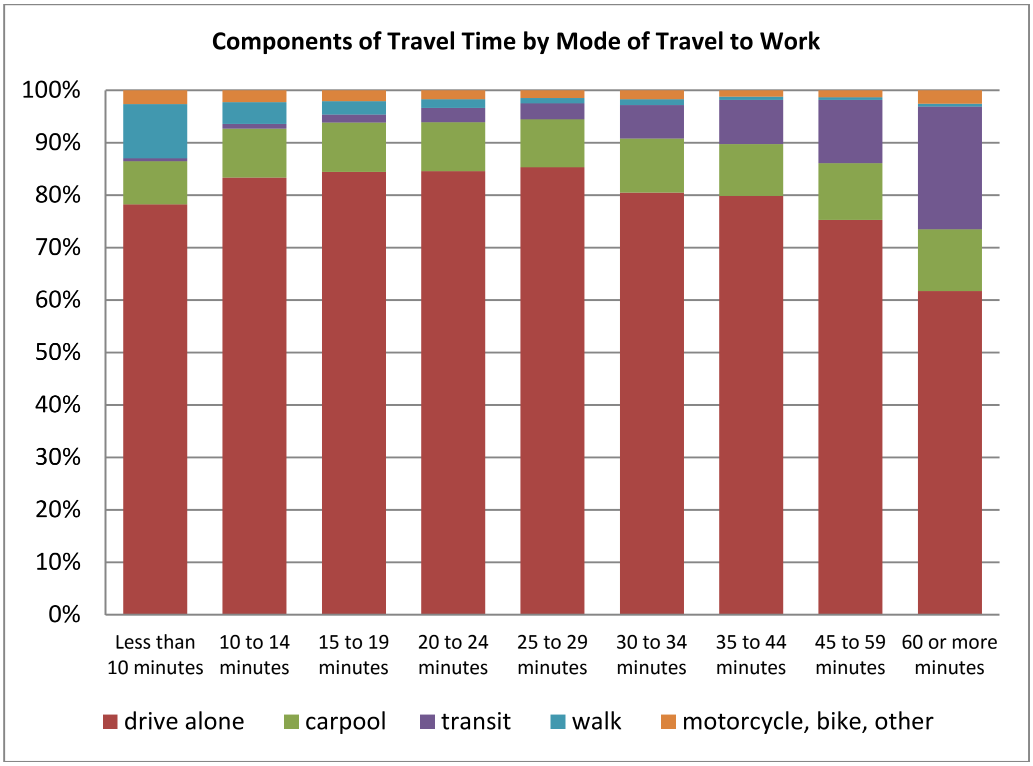
The average travel time is of course a function of the modes of transportation used. The following shows the variation in travel times by mode. Among the keys are that almost 40% of transit users take 60 minutes or more to get to work; and over 60% of walkers arrive within15 minutes.

Figure 2.21. **Travel time distribution by mode of travel to work**



Source: US Census Bureau, American Community Survey 2014

Figure 2.22. **Components of travel time by mode of travel to work**



Source: US Census Bureau, American Community Survey 2014

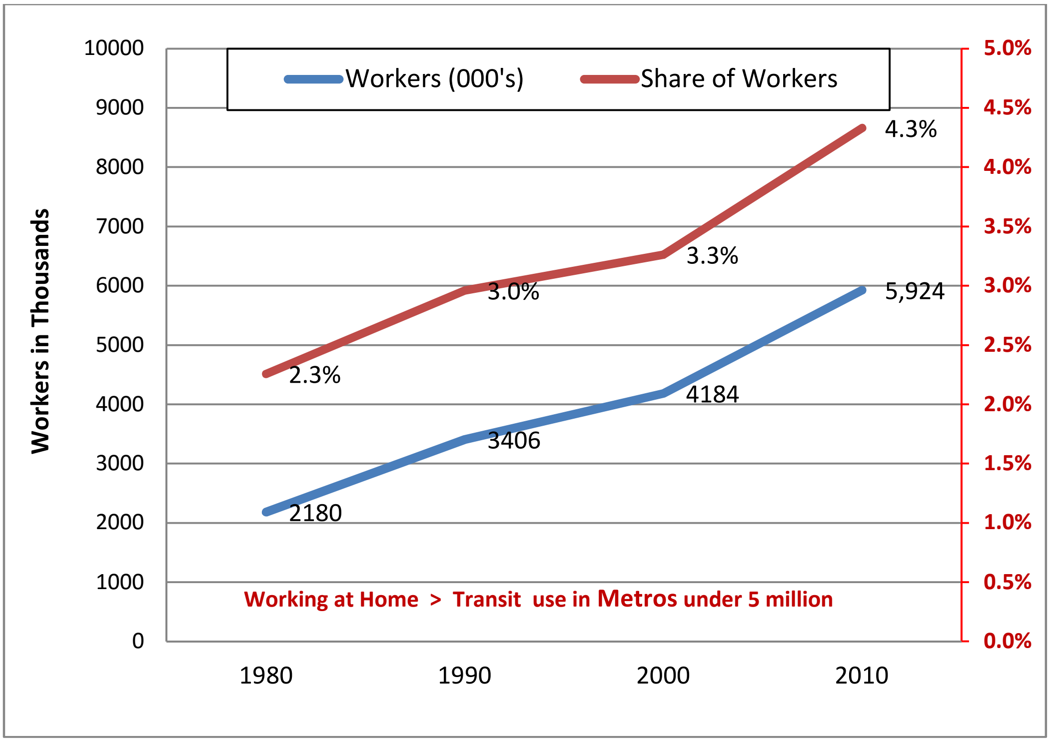
As mentioned earlier the role of transit is in the 30 minute and beyond categories. Transit represents almost a quarter of all trips made at 60 minutes or more. Note also that walking is a significant component, on the order of 10%, of work trips of less than ten minutes.

Trends in mode use

This discussion has proceeded without a complete reckoning of how people get to work in America.

Just above, it was noted that 6.5 million people worked at home in 2014. The long-term trend is dramatic in nature and important in scope; it has tripled since 1980. The figure below indicates that work at home has grown from 2.2 million in 1980 to almost 6 million in 2010 (and as indicated above added another 600 000 in the 4 years since.). Rising from a 2.3% share in 1980 to 4.3% in 2010 and holding the same share in 2014. Of interest is that 3/4ths of those who work at home have multiple vehicles available for their use.

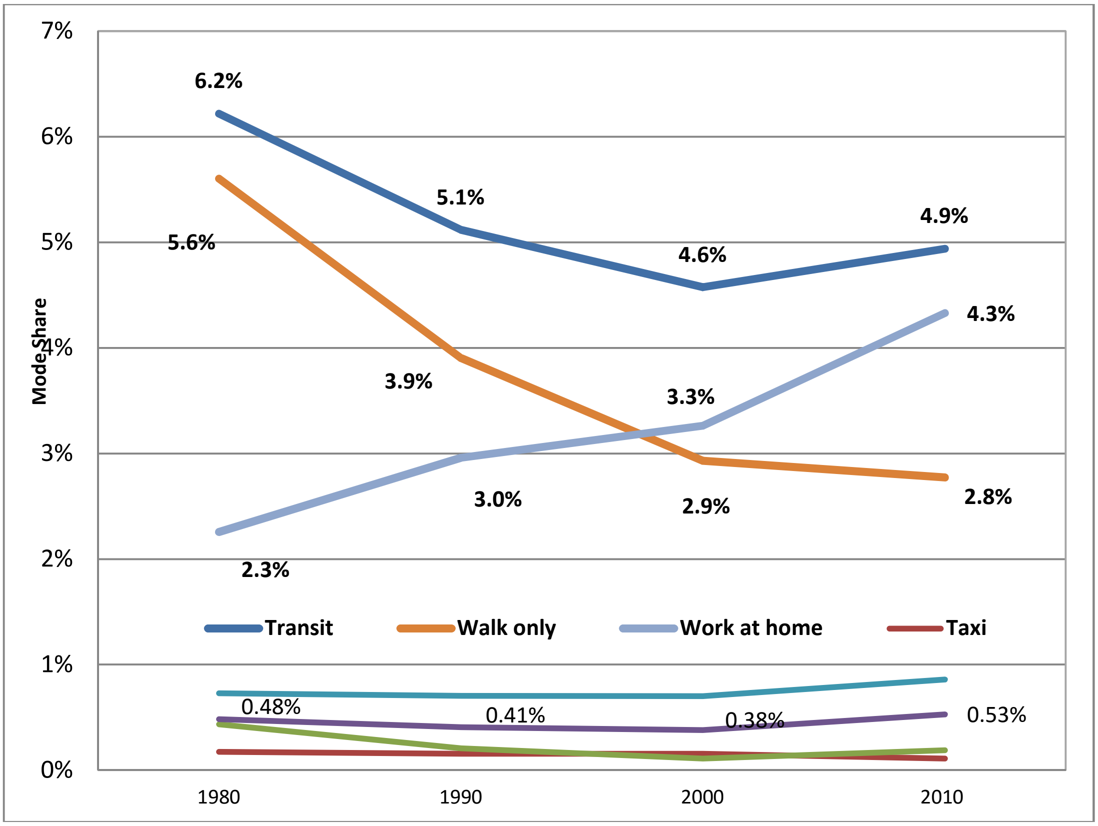
Figure 2.23. **Long term trends in working at home**



Source: US Census Bureau, US Decennial Census

To better frame this statistic, the following figure brings together the mode of work travel in the middle range and in the minor ranges.

Figure 2.24. **Long term trends in the middle and minor modes**

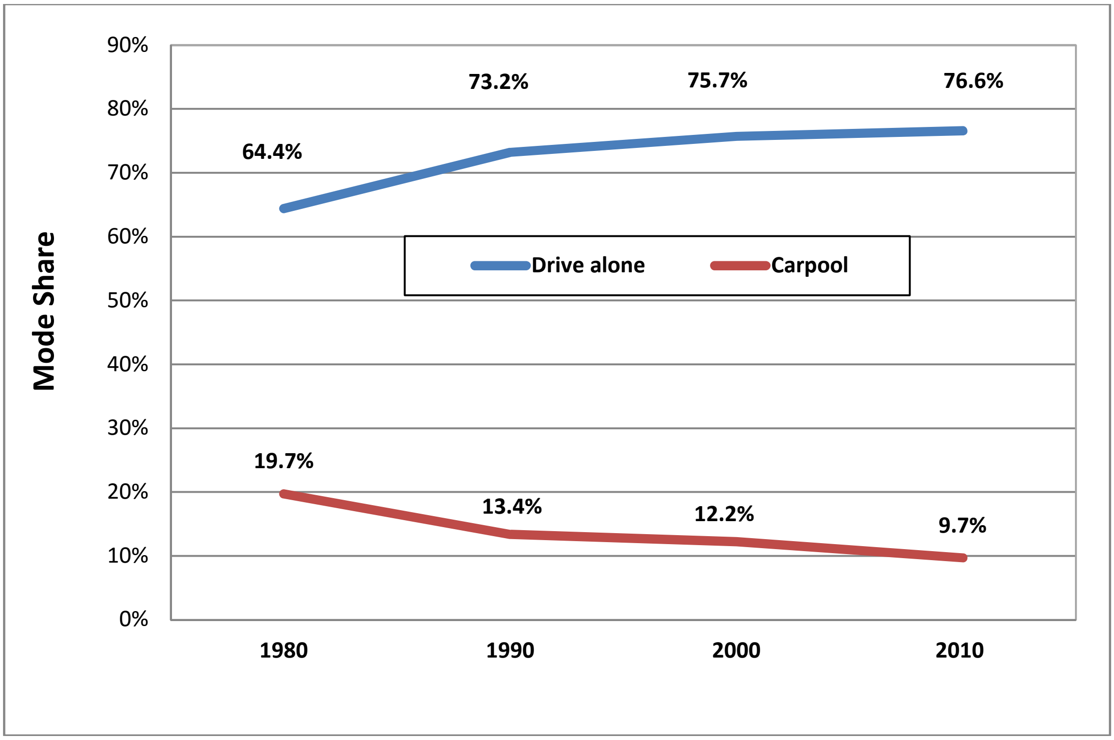


Source: US Census Bureau, US Decennial Census

The figure above refers to the middle and minor modes. The middle modes are those in a range of 2% to 5% of commuting; while the minor modes are those defined as less than 1% of work travel.

For statistical completeness the major modes are shown below. The decline in carpooling, discussed earlier is shown here losing more than half its share of travel from 1980 to 2010. The Driving Alone mode after a sharp increase in the eighties has registered modest increases per decade. The overall share of the auto-based modes then was 86.3% showing some overall growth despite the sharp declines in carpooling.

Figure 2.25. **Long term trends in the major modes**



Source: US Census Bureau, Commuting in America 2013

The advent of new technologies and new approaches to transportation demand

Many new technologies seem to be on the horizon for transportation promising substantial change. One of the attributes of these potential changes is the time line questions expressed either in years or in decades. The degrees of freedom and the variations in conceptual approaches vary sharply and make planning an almost fruitless exercise.

The one technological change that is here now and generating substantial positive and negative disruption is the work of Transportation Network Companies, such as Uber and Lyft, which arrange travel among private providers and users. Their immediate impact, of course, is on the regulated taxicab industry all over the world. They have found immediate positive response from both users and providers, but have generated complex and varying governmental responses to their approach to service. It will be some time before the balances between the heavily regulated cab industry and these new providers are resolved, and a more level playing field established. If nothing else, they have demonstrated how fast-moving, nimble technology companies can quickly out-perform government response.

However, their prospective influence goes well beyond the competition with old-line regulated cab operators. They challenge private vehicle carpooling and transit usage, and even small package delivery systems. American carpooling has been in decline ever since measurement began in the 1980's. Carpooling was responsible for moving almost 20 million workers in 1980 and was down to just above 13 million by 2010. Today in San Francisco the home of the Uber start-up, their carpooling usage exceeds their replicated-taxicab services. Many in transportation planning, particularly in the United States, have long seen carpooling and van pooling as the greatest potential resource for responding to transportation work commute issues, recognizing that the great unused resource are all the empty seats in a car driven by a solo driver, but governmental efforts to expand vehicle occupancies have had very limited success. Today carpooling has fallen below a 10% share of work travel in the US, for many complex economic and demographic reasons, some discussed above. The potential for TNC's to resurrect vehicle pooling using real-time internet tools, as opposed to the more rigid past arrangements can change commuting patterns dramatically drawing from taxicabs, from personal drivers and from transit. The implications of this seem positive but the full implications are unclear. Moreover, added to the potential vehicle fleet are new rental models that include kiosks for cars and for bicycles such as car2go, carshare, bike rentals, bikeshare on an hourly or daily basis. Again, given their nascent nature the roles of these semi-modes are unclear.

Given that Uber-like systems have such substantial potential, imagine a world where the Uber vehicle is driver-less – an autonomous vehicle that can provide similar services at far lower costs and probably lower energy and environmental costs as well. If the concept of a fully autonomous vehicle is considered, either individually owned or available on a service to use basis, the implications are massive.

Consider, for the typical metro area the nature of travel demand as in the following broad demand typology:

Table 2.9. **Autonomous vehicle implications by trip purpose at the metro level**

Demand typology	Impact	Areas affected
Commuting	High	Alternative use of time, stress reductions
Other Resident Travel	High	More access for young, old, infirm
Tourism	High	Increased opportunities
Service Vehicles	Low	Demand mostly unaffected
Public Vehicles	Low	Demand mostly unaffected
Urban Goods Movement	Low	Delivery functions unaffected, cost changes
Thru Passenger Travel	High	Increased ease
Thru Freight Travel	High	Increased ease and cost changes

These factors focus on the direct demand impacts, other than the much broader general impacts such as increased safety, increased speed, reduced vehicle weight savings, fuel savings and ownership costs.

All of these factors are likely to induce greater ease and reduced impediments to travel resulting in more trips, of longer lengths among an expanded user base (those too young or old, or impaired to drive). However, there are many degrees of freedom in the potential that are open questions which will affect the potential benefits; among these: whether trips are shared or not; whether vehicles park or move on to other uses; what mode shifts will occur in both passengers and freight; and what are the long term land use implications.

In the broadest perspective, it should be seen as a positive step forward for a greater potential market, providing greater access to jobs, workers, social opportunities, services and suppliers. However, there are serious questions that challenge us at this time:

- There are degrees of autonomy. How does the society function in a partly autonomous world?
- The pace of introduction is estimated anywhere from 5 to 50 years with great transition issues.
- Who will own the fleets: individual owners; rental agencies; manufacturers; governments?
- Substantial legal, liability and infrastructure issues are to be resolved.
- Are all consequences benign environmentally and socially?

- Is the shift from a high capital-low operating cost approach now in use to a low capital-high operating cost regimen positive or negative for the economically disadvantaged? What are the trade-offs?

- The employment impacts could be massive; vehicle drivers such as taxis, delivery vehicles, over the road trucking are a major occupational category. A driver's license has been one credential that has opened job opportunities for many, especially the less educated.

These questions and more are unanswerable, except in a very speculative sense, at this time. These issues will play out over the coming decades. They all raise the question as how does planning function in this environment. How might a city plan for a transit system, or a highway, which will take 20 years to complete, in an environment that could obviate the need for such a system before that time?

Concluding thoughts

This limited survey of critical trends now operating in the United States, while not exhaustive does serve to examine some of the dramatic challenges facing the nation in the years ahead. Other countries may share some or many of these same challenges.

The primary concern has to be where will the workforce come from to replace the baby-boomer workforce now moving off stage. They will need to be replaced in both numbers and skills. New skills will be required as well. Among the concerns are these:

- The dependency ratio will shift from workers supporting children to supporting older populations

- At the same time a goal for the society must be to retain large numbers of the over 65 population in the work force. Their health and work focus can help make this possible but the work travel and other mobility questions will be a safety and economic challenge. Many already are achieving this role by working at home – which is a modern solution to many challenges. The work at home workforce makes no demands on the society for infrastructure or services.

- It is likely that the work world will be highly varied in terms of time and effort. Part time employment and even full time employment with very varied schedules will challenge employers, benefit travel congestion and better serve family needs.

- In order to sustain the kinds of life styles now achieved and to extend it to those with lesser economic means, as well as to support the growing dependent populations, greater worker productivity will be essential. New technologies will be a great help, but the critical factor will be education, particularly serving the lower income population and the immigrant populations.

- Given the challenges of finding the needed skilled workers, employers will go to where the workers are or where they want to be. The combined needs of skills and education will make universities natural attractions for growth. Many, if not most, employment occupations will be "foot-loose" in that they can locate almost anywhere which has communications and transportation support.

- Only the resource dependent work sites requiring access to minerals or farm products or transportation hubs will be determined by geographic constraints, others can be amenities-based. This will often be the larger metro areas, which as a result will get even larger filling the needs of employers and workers for an adequate commuter-shed in scope and scale within an acceptable range in time, distance and cost.

- Thus, there will be a mix of close-by walkable/bikeable opportunities at the same time long distance commutes reaching accessible jobs and affordable, desirable housing and communities will grow.

- New technologies and new organizational arrangements that are information/communications based will abet and at the same time challenge, traditional transport infrastructure and services.

- With increasingly autonomous vehicles safety, speed and utility of the road system will be enhanced. In some cases, the autonomous vehicle/transit dyad will prove effective.

- Ultimate questions of who owns what kinds of vehicles, making private and public options far more complex and creating new cost structures that promise reduced costs but with many questions remaining to be resolved.

- The transportation labour force itself – vehicle fleet drivers, taxicabs, bus drivers, truck operators – approaching 10% of the labour force in some countries all will be operating in a new and challenging environment with job opportunities in serious question.

- Long term infrastructure planning and development will be in question given the uncertainties and prospects of new and revolutionary transport services and operations.

- The challenges of planning and policy making in this environment will call for far broader understanding of the implications of future trends. Projecting the present into the future beyond the near term will be a hazardous undertaking.

- Will the low-income population be better off or worse off in this new world? The greater speed and lower prospective costs of accessibility to services and opportunities should be a positive and unifying force increasing the ability of the disadvantaged to better engage fully in the society. That needs to be the goal driving much of the decisions that must be addressed.

Notes

[1] Commuting in America 2013 Brief 4 Population and Worker Dynamics.

[2] A CU is similar to a household except in some shared households in which each person is responsible for their own food, housing, and other expenditures each person is considered a Consumer Unit, e.g. college students in shared housing. There are 127 million CU's in the 2014 Consumer Expenditure Survey, while the Census Bureau sets 2014 households at 117 million.

References

US Bureau of Labor Statistics (2015), Consumer Expenditure Survey, https://www.bls.gov/cex/ (Accessed 6 April 2017).

US Census Bureau (2015), Geographical Mobility: 2014 to 2015, https://www.census.gov/data/tables/2015/demo/geographic-mobility/cps-2015.html (Accessed 6 April 2017).

US Census Bureau (n.d. a), American Community Survey, https://www.census.gov/acs/www/data/data-tables-and-tools/index.php (Accessed 6 April 2017).

US Census Bureau (n.d. b) Historical Income Tables: Households, https://www.census.gov/acs/www/data/data-tables-and-tools/index.php (Accessed 6 April 2017).

US Census Bureau (n.d. c), 2010 Census Data, https://www.census.gov/2010census/data/ (Accessed 6 April 2017).

US National Academy of Sciences (2013), "Commuting in America", Transportation Research Board, https://www.census.gov/acs/www/data/data-tables-and-tools/index.php (Accessed 6 April 2017).

Chapter 3
How equitable is access to opportunities and basic services considering the impact of the level of service? The case of Santiago, Chile

Ricardo Hurtubia

Pontificia Universidad Católica de Chile, School of Architecture & Department of Transport Engineering and Logistics, Santiago, Chile

Juan Carlos Muñoz

Pontificia Universidad Católica de Chile, Department of Transport Engineering and Logistics, Santiago, Chile

Ignacio Tiznado-Aitken

Pontificia Universidad Católica de Chile, Department of Transport Engineering and Logistics, Santiago, Chile

Cities face the daily challenge of providing people with access to different activities through their public transport systems. Despite its importance, there is little research on accessibility that focuses on the use of this mode and even less accounting for the impact of level of service (i.e. travel time, waiting time, reliability, comfort and transfers). Thus, the aim of this chapter is to propose a methodology to determine how access to opportunities and basic services through public transport systems is distributed in cities, and how the perceived level of service decreases or accentuates the existing gaps.

Three indicators are calculated for Santiago based on data from public transport operations, smart card validations and georeferenced information: walking accessibility to public transport stops considering the quality of urban furniture, safety and environment; connectivity provided by the system in each area to the rest of the city considering the level of service through a measure of generalised time (in-vehicle time); and a measure of attractiveness of the destinations, based on number of trips attracted by purpose. The methodology is applied to a case study in Santiago, a highly unequal and segregated city.

The results show that the accessibility gap between disadvantaged areas and more wealthy neighborhoods of the city increases if the user's perception of level of service for public transport is considered. We show that the three proposed indicators provide different dimensions of accessibility suggesting how and where to intervene to effectively improve equity. Thus, the indicators could be used to assist the prioritisation and focus of investment plans, the design process of urban policies or transport infrastructure and become a key input for planners and decision-makers.

Introduction

The spatial gap between the activities that people do and their homes generates travel needs and therefore demand for transport, which in turn influences the land use system and activities distribution. Hence, while this distance exists, accessibility, understood as how easily you can reach an activity from one location using a particular transport mode (Dalvi and Martin, 1976), is and will remain as a central focus of transportation research (Martellato and Nijkamp, 1998).

However, conventional transportation planning has generally focused more on mobility and the physical journey, related to number of trips, distance and speed. This approach is more concerned about mass transport (how to move the most people efficiently) than social transport, which focuses on people's accessibility (Betts, 2007). The latter approach is particularly relevant because, in urban settlements, lack of access to transport can mean a lack of opportunities for work, study, recreation and social interaction, which can profoundly impact people's quality of life and development (Lucas, 2006).

The main objective of cities should be smart growth, with emphasis on equity, non-motorised modes and public transport (Litman, 2003), especially considering that the majority of population with the greatest needs is captive of this system by not having a car available. Despite its importance, Martin et al. (2002) and Mavoa et al. (2012) note that there is little and limited research on public transport accessibility.

In addition, Lei and Church (2010) show that most studies on this subject are focused only on proximity to public transport stops (physical accessibility), regardless of quality of urban furniture, urban environment and quality of public transport services. This last point is vital because, as expressed Lucas et al. (2016), there is an urgent need to consider the quality of service in people's travel experience in public transport and non-motorised modes.

Thus, the main objective of this work is to develop accessibility measures accounting for quality of service. We compare traditional accessibility measures – that consider only travel time or an impedance measure composed by different level of service variables with the same weight - with a new approach based on disaggregated indicators that also take into account urban environment and level of service impact in time perception and trip quality. A secondary objective is to use Santiago de Chile as a test field for the proposed measures, i.e. to study how Santiago's public transport system meets the need for access to opportunities and basic services.

The accessibility indicators proposed here could be used to assist the prioritisation and focus of investment plans, the design process of urban policies or transport infrastructure and become a key input for planners and decision-makers. Thus, this work attempts to contribute to the equitable development of the city, achieving the levels of accessibility and connectivity needed for social and economic development and reducing inequality gaps.

The chapter is organized as follows: the first section provides contextualisation of Santiago in terms of segregation, equity, mobility and access. The second section shows a brief literature review about accessibility measures and proposes three accessibility indicators: 1) accessibility to public transport stops taking into account the quality of urban furniture, safety and environment; 2) connectivity provided by the system in each area considering the level of service (travel time, waiting time, reliability, comfort and transfers) through a measure of generalized (in-vehicle time) and; 3) a measure of attractiveness of the destinations, based on number of trips attracted by purpose. The fourth section shows results for the application of these three accessibility indicators to the case study of Santiago. Finally, the last section analyses and discusses the results in terms of land use and transport planning and equity, ending with some conclusions and recommendations about project-prioritization and public investment.

Context: Santiago, Chile

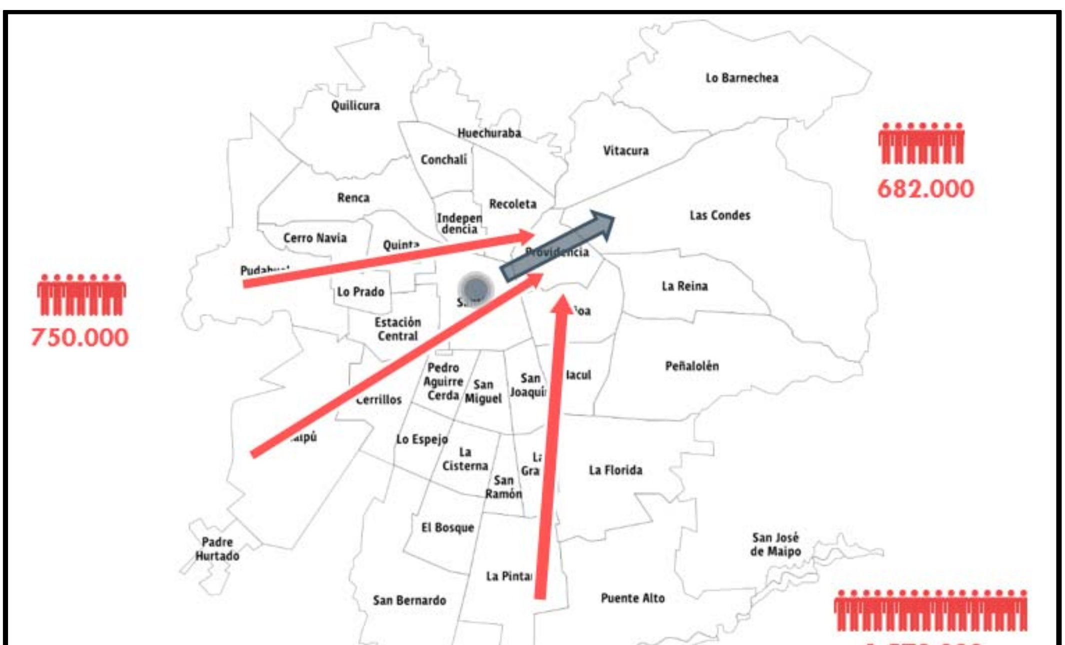
Santiago is the capital of Chile and its largest metropolitan region. It has a population of over 6 million people within an area of approximately 640 km^2. This section addresses Santiago's significant social segregation, land use and inequality problems. It also provides an overview of its public transport system and the evolution of its modal share.

Land use, segregation and inequality

Santiago suffers from a high socioeconomic residential segregation and income inequality. This is not surprising since Chile has one of the highest Gini coefficient within OECD countries; the income ratio between the wealthiest and poorest 10% in the country is 26 (OECD, 2015), while 9.2% of the population still lives below the poverty line (MDS, 2013).

The high-income elite in Santiago lives in its north-eastern area (Rodriguez, 2008). In the last decades, this area has grown much faster than the rest of the city, attracting productive activities, commerce and services. As shown in Figure 3.1 it has become an extension of the historic business district located in the centre of the city. Due to weak planning instruments and a lack of integrated land use and transport planning, the activity centre has moved chasing higher-income households (and their purchase power).

Figure 3.1. **Activity centre evolution.**

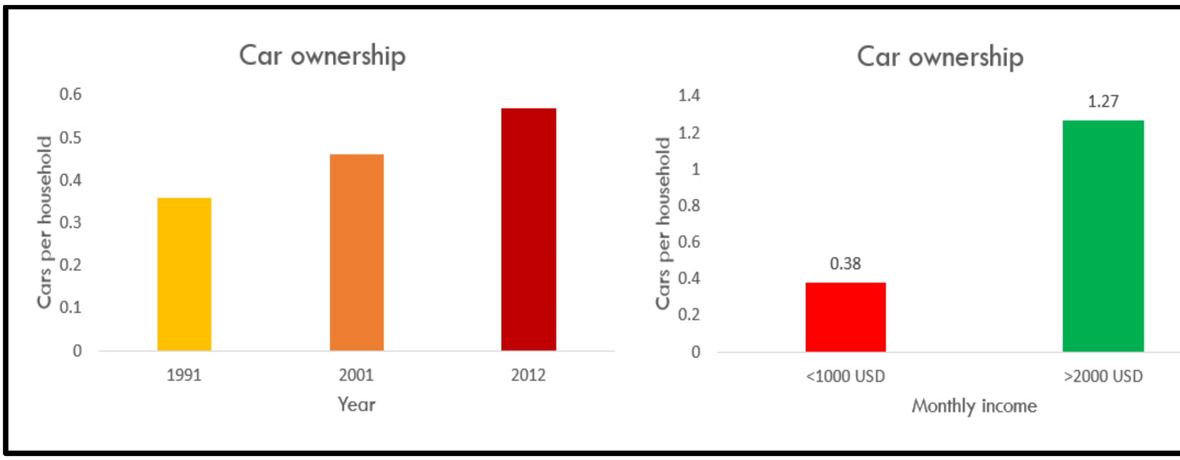


Note: In 1970 it was located in the historical city centre (Santiago) and it has moved towards Providencia and Las Condes. This affects the, much larger, lower-income population by forcing longer trips

This evolution has affected the low-income population, especially those living in the periphery. Until the 1980s, Santiago had several slums, conveniently located near the centre of the city. As a strategy to eliminate slums, their inhabitants were offered social houses, mostly located in the periphery of Santiago. The growth and expansion of the city concentrated in these "bedroom communes" that lacked the diversity and quality of job and study opportunities offered in their former locations. A large part of the low-income population still lives in these areas, which require long commutes. Rodriguez (2008) notes that this pattern of numerous trips from poor communes (usually peripheral) to business centres (downtown and high-income areas) is common in Latin American metropolitan cities

This phenomenon is clearly observable in Santiago forcing a significant portion of the low-income population to travel long distances. Not surprisingly, Santiago has increased its car ownership over time, but this increment is not equally distributed: 59% of households do not have access to a car and are still captive public transport users. Figure 3.2 shows the evolution of cars per household between 1991 and 2012, and the large car ownership gap between high-income and low-income households.

Figure 3.2. **Car ownership in Santiago**

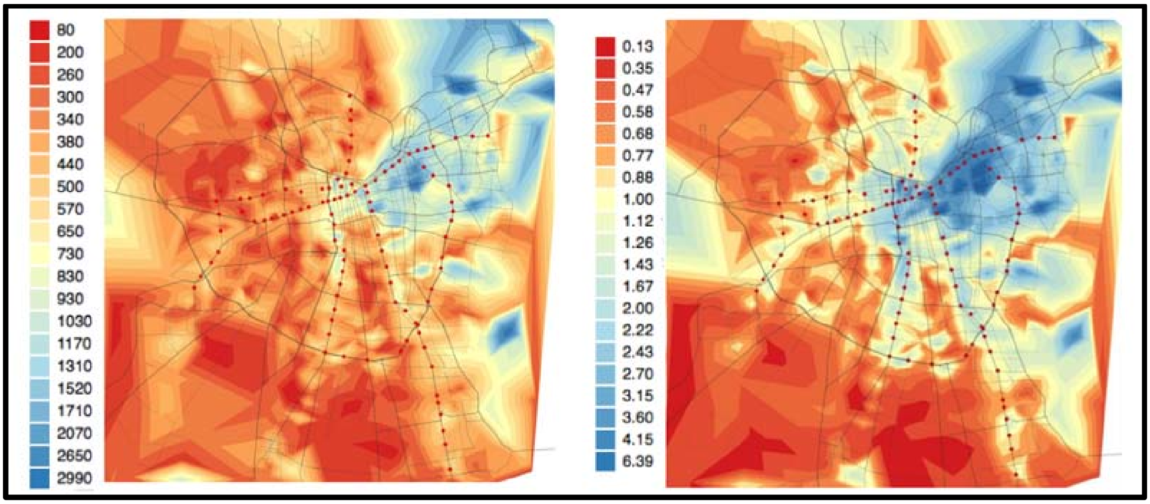


Note: Evolution (left) and current distribution according to income (right). 16% of households have monthly household income above USD 2 000 while 23% is below USD 1 000

Source: Own elaboration, based on SECTRA (2015).

This urban context has important consequences in accessibility and mobility. Travel time from low-income communes has increased due to their peripheral location (Sabatini et al., 2001; Rodriguez, 2008) and due to trips that have grown in length. This impoverishes the accessibility of this group to activities and urban services. As an important example, take accessibility to employment: the eastern sector of the city is privileged due to a high concentration of jobs. A clear correlation between income and proximity between workplaces and homes becomes evident (Figure 3.3). This generates a big impact in terms of equity and social exclusion (Hidalgo, 2007; Rivera, 2012) and a situation that is hard to overcome just by improving the transport system.

Figure 3.3. **Income distribution in Santiago (left) and accessibility to employment using public transport (2012) (right)**



Note: The map uses a standard measure, which depends on the number of opportunities and the generalised travel cost

Source: Niehaus et al. (2015).

Since Santiago does not have a metropolitan authority to ensure a coherent development of the city, the prospect is not promising. Actually, each of the 37 communes has its own mayor, budget and regulations, making land use regulation something than can be easily changed and creating incentives to attract business activities to its niche. Also, this has consequences in transport infrastructure, as public transport users do not necessarily vote in their destination communes, generating little continuity of the basic transport structure (such as bike paths or public transport corridors).Additionally, there are loose requirements for new real estate developments in general and social housing in particular. Table 3.1 describes the set of accessibility conditions a housing units project must fulfil to benefit from social housing subsidies. These conditions not only ignore access to job opportunities, but also are insensitive to the quality and capacity of the services being considered (e.g. a school within 1 000 metres becomes useless for the new inhabitants if it is already at its capacity).

Table 3.1. **Conditions for a housing units project to benefit from social housing subsidies**

Basic service	Condition
Education	Less than 1 000 meters
Health	Less than 2 500 meters
Public transport	Less than 500 meters
Work, public spaces and other services	No conditions

Source: MINVU (2012).

Thus, the regulation in Santiago is quite weak in terms of integrating land use and transport needs. As will be shown in this chapter, this gap affects accessibility to different types of opportunities in different areas of the city. To provide a context of the transport system in Santiago, the next section describes the evolution of its public transport system and modal split.

Transantiago and modal share evolution

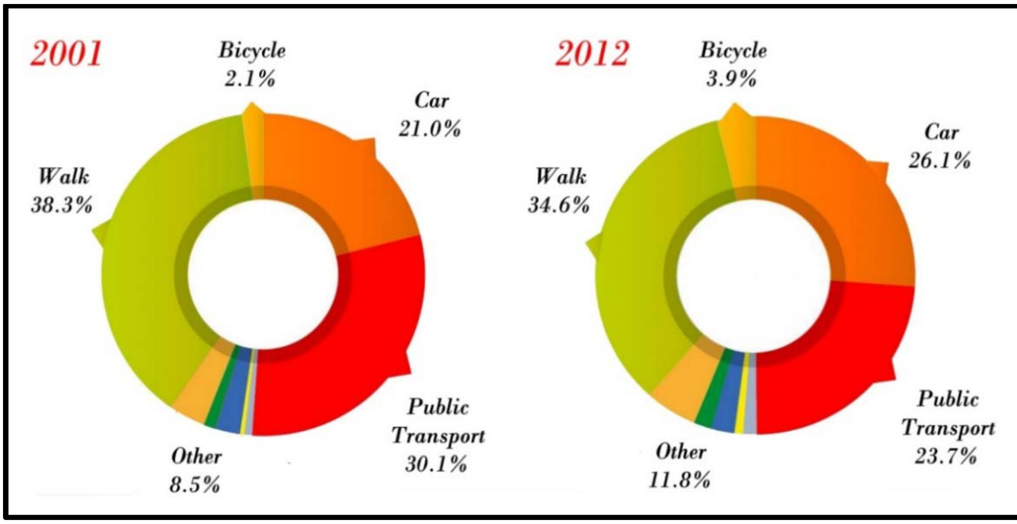
Public transport in Santiago experienced significant changes during the last decade. Until 2007 the bus system consisted in the semi-formal "Micros Amarillas" (Yellow Buses), with atomised bus property, no fare integration, intense service overlap on the main arteries of the city (meaning more congestion), high accident rates and being overall perceived as one of the worst city services by the population (Diaz et al., 2006).

In 2007 a new city-wide public transport system was implemented, named Transantiago, which aimed to improve operator regulation, eliminate competition for passengers on the streets and reduce the number of accidents and environmental externalities, among other goals.

However, after its inauguration, the system had very serious problems affecting users directly in the quality of their trips. In addition, a significant financial deficit started to grow. Even though quality of service later improved, most citizens in Santiago consider Transantiago a failure (Muñoz and Gschwender, 2008; Muñoz et al., 2014). An important part of this failure had to do with the overnight operational start for the whole system (or "big bang" implementation), not leaving enough time to allow users to adapt to the new smart-card payment and trunk-feeder structure. There were also poorly designed contracts for the operators, who did not have strong enough incentives to comply with the required frequencies and headway regularity. Additionally, a significant part of the infrastructure (mainly BRT-type corridors and exclusive lanes) was not built at the time the system started operating.

This brought important consequences. Between 2001 and 2012, the use of public transport in Santiago decreased (even though public transport share has been declining systematically for decades). Although some of this drop probably happened before 2007, it is reasonable to associate it to Transantiago not providing the level of service necessary to attract users and to the bad image acquired during its first months of operation. The share of walking trips decreased while car trips increased by 5% (see Figure 3.4), although it is hard to tell if this is a direct consequence of Transantiago's implementation. Cycling increased significantly, mostly in high-income areas where it was almost non-existent. This increment is probably due to the low service of Transantiago and the increasing congestion in that part of the city where car ownership is the highest.

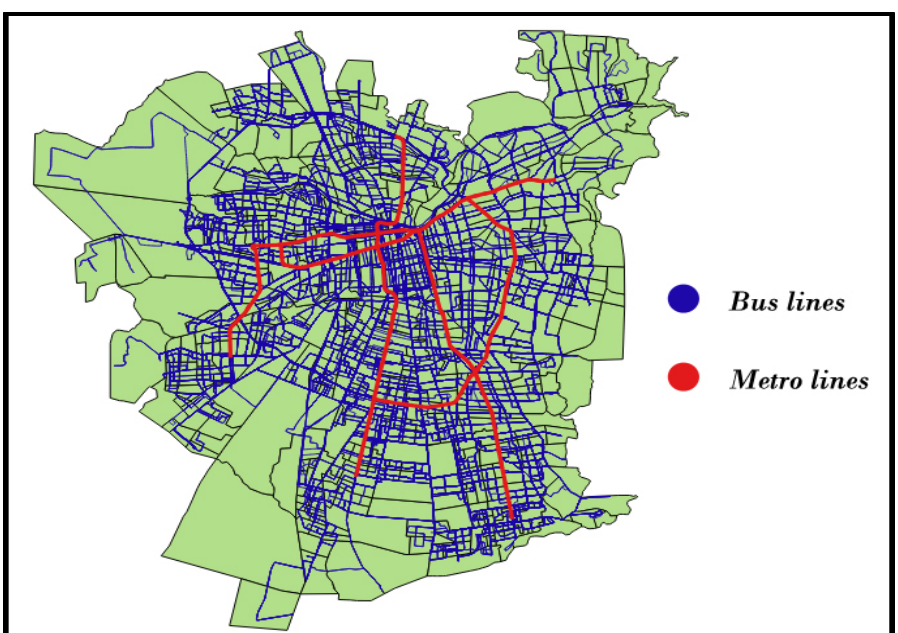
Figure 3.4. **Modal share evolution in Santiago, Chile**



Source: SECTRA (2015).

Nevertheless, not everything brought by the new system was bad. Before Transantiago, Metro (the subway system) was underutilised, serving mainly those living next to Metro stations or those who could pay double fares (mainly middle and high-income segments). Currently, Santiago's Metro network has 103 km, and is used intensively thanks to the integrated fare and a bus system that feeds it, which has allowed greater coverage (see Figure 3.5). In the following sections, we review accessibility measures used in the literature and propose ways to translate this coverage into an index accounting for urban space quality and the level of service of public transport.

Figure 3.5. **Santiago's public transport network**



Source: Own elaboration, based on DTPM (2016).

Accessibility measures

A large number of different measures for accessibility, defined as the potential to reach opportunities that are spatially dispersed, have been proposed in the literature and used to address important questions of policy and planning (Páez et al., 2012). According to Geurs and Van Wee (2004), there are four types of accessibility measures:

- based on infrastructure, where infrastructure level of service is analysed (e.g., congestion and average speed in a transport network) (AVV, 2000; DETR, 2000);
- based on location, which describes accessibility to activities from given locations (e.g., potential, isochrones, adapted-potential) (Ingram, 1971; Van Wee et al., 2001);
- based on the person, taking into account personal differences and time restrictions (based on Hägerstraand's space-time geography) (Kwan, 1998; Neutens et al., 2008);
- based on utility, related to economic benefits from accessibility (e.g. balancing factor benefit and logsum benefit measures) (Martinez, 1995; De Jong et al., 2007).

Most of these accessibility measures have two parts: a transport component depending on distance, travel time and/or cost, and a component related to activities, which should describe how attractive each destination is for performing an activity like, for example, the quantity or quality of the opportunities or facilities to perform the activity (Burns, 1979; Koenig, 1980; Handy and Niemeier, 1997).

We propose using a measure based on location, specifically Potential Accessibility measures, also known as Gravitational Accessibility, proposed originally by Hansen (1959) and Ingram (1971). These measurements consider all possible destinations (weighted by their importance) and use an "impedance function" within the indicator, making the accessibility decay with the distance, cost or travel time. Despite not being as easy to interpret and communicate as the (much more popular) isochronous measures, they allow to evaluate the combined effects of transportation and land use, without imposing an arbitrary threshold for distance or time in which all destinations are equally attractive. Furthermore, this type of accessibility measure is appropriate as a social indicator when used to analyse the level of access for different socioeconomic groups (Geurs and van Wee, 2004).

Despite the abundant research in accessibility measures, there is little literature evaluating accessibility, mobility and connectivity by public transport considering the perspective of the users (Cheng and Chen, 2015). One of the most relevant elements to consider should be user perceptions regarding quality of service. Therefore, we propose to build three indicators to analyse access by public transport on an unbundled basis.

- Physical Accessibility Index (PAI): Access to public transport stops taking into account a proxy of walking quality (Cheng and Chen, 2015). We analyse the quality of urban furniture, safety and environment.
- Public Transport Index (PTI): Connectivity provided by the system based on public transport zonification of the city accounting for perception of travel time, waiting time, reliability, comfort and transfers, i.e., different weights for each variable within generalised travel time.
- Attractiveness Land Use Index (ALUI): Attractiveness of the destinations, based on number of trips that each area attracts by basic purposes, i.e., work, education, health, recreation and shopping (SECTRA, 2015).

The methodological details of each indicator are described next, including a discussion on how they contribute to a better and more complete analysis of city fairness in terms of access to opportunities and basic services.

Physical Accessibility Index (PAI)

Calculating walking accessibility to public transport stops requires defining various elements: accessibility functional form, level of disaggregation of the city, walking speed and finally, how to measure the travel quality during this stage.

As we pointed out before, this chapter uses measures based on location, specifically based on potential or gravity. These measurements use the decay of accessibility based on a parameter of resistance and can overcome the arbitrariness of the isochronous measures where there are no objective conventions to define neither thresholds nor the ability to assess the opportunity based on their proximity, since everything located within the isochrones limits is considered equally attractive and accessible (Geurs and van Wee, 2004). We propose to use the indicator described in equation (1):

$$A_i = \sum_{j \in \varphi} F\left(\frac{d_{ij}}{v}\right) \qquad (1)$$

Where i is localisation (origin) and j corresponds to public transport stops. Meanwhile, φ is the set of 10 public transport stops closest to i and $F\left(\frac{d_{ij}}{v}\right)$ corresponds to impedance function, which depends on the distance d_{ij} and average walking speed v. For simplicity, we use Euclidean distances and a conservative value for the speed of 3.6 km/hr v. Since the actual distance that users experience when walking through the network is greater than the Euclidean distance, a correction factor that varies between 1.2 and 1.35 based on five values reported by Gonçalves et al. (2014) is applied to d_{ij}.

Most studies use Power, Gaussian, Logistic or Negative Exponential impedance functions (Handy and Niemeier, 1997). However, the literature generally puts little attention on the functional form and on how it relates to actual human behaviour. In this work, we use the Richards Function, tested by Martinez and Viegas (2013), similar to a Logistic function (see equation 2).

$$F\left(\frac{d_{ij}}{v}\right) = \frac{1}{\left(1 + Qe^{-B\left(\frac{d_{ij}}{v} - M\right)}\right)^{\frac{1}{V}}} \qquad (2)$$

where B is the growth rate,

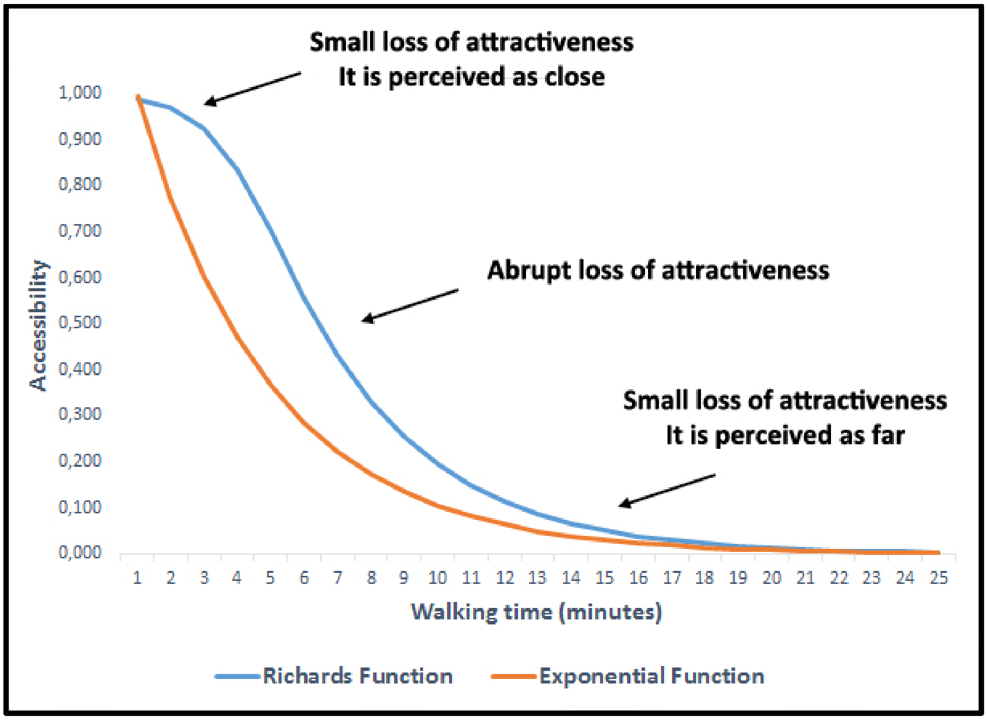
V affects near which asymptote growth occurs,

Q depends on the value F(0),

M is the time of the maximum growth

Figure 3.6 displays graphs of the Negative Exponential and Richard functions. Martínez and Viegas (2013) argue that the second one represent better people's perceptions by softening accessibility decay for low travel times. To calibrate and set the maximum threshold walk to public transport we use information from origin destination surveys in Santiago (SECTRA, 2015).

Figure 3.6. **Differences between accessibility impedance functions: Richards and Negative Exponential**



Source: Own elaboration, based on Martinez and Viegas (2013).

PAI has its maximum value (1) when travel time is 0-1 minutes because the opportunity or service is adjacent to the origin. Using the proposed method by Mamun et al. (2013), we observe that 95% of public transport users walk less than 15 minutes to their initial stop, so we define an access value of 0.05 for 15-minute walk. Using the same methodology, we define an access value of 0.2 and 0.7 for 10-minute and 5-minute walk respectively. The parameters obtained based on this calibration are shown in Table 3.2.

Table 3.2. **Estimated parameters of Richard impedance function**

Parameters
Q = 5,49 E-05
B = -1,09
M = -5,09
v = 4,02

Regarding disaggregation of the city, we use 804 zones that the Metropolitan Public Transport Directory (the entity that manages and regulates Transantiago) regularly works with. These zones are small enough to avoid spatial aggregation errors and to allow us to calculate accessibility based on relatively homogeneous locations.

To obtain a measure of the level of service while walking, we used georeferenced information of Santiago pre-census (INE, 2011). In this data, each city block is evaluated by a group of trained surveyors who rate several aspects of public space using a binary scale with 1 meaning the presence of the element and 0 meaning lack of the element.

Two particular aspects (sidewalk and street quality) are rated with a scale of 1 to 5, with 1 meaning poor conditions and 5 meaning excellent conditions. Based on this, and grouping elements according to their similarity or affinity, four indexes were created, which together form the Environment and Urban Quality Index (EUQI) described in Table 3.3.

The aggregate EUQI values range between 2 and 19 and are analysed as a complementary indicator of accessibility. Traditional accessibility indicators only considering walking time between locations and public transport stops seems insufficient since it ignores, for example, how safe or comfortable this walk may be.

Table 3.3. **Components of EUQI and his values**

Index	Components	Range of values
Security/safety	Luminary, road signs and roofed bus stops	0 to 3
Environment	Gardens, seats, sport fields and playground	0 to 4
Cleanness	Garbage bins and rubble	0 to 2
Infrastructure	Sidewalks and streets quality	2 to 10

Public Transport Index (PTI)

To calculate this component, we use the same functional form from the Physical Accessibility Index (see equation 1), but instead of considering just the walking time from each origin to the closest bus stops and/or subway stations, we account for the total (perceived) generalised travel time experienced by the user from the initial station or stop to the final one. Thus, to calculate the connectivity and level of service provided by public transport, we incorporate frequency, regularity, travel time, transfers and comfort experienced on the trip. This requires information about system operation and data from smart card validations.

To analyse what is the impact of using this type of accessibility measure compared to traditional indicators (which usually ignore different travel components such as walking and waiting time or do not distinguish it from in-vehicle travel time), we use a generalised time function to account for different dimensions of the level of service, disaggregating trip components and transforming them into equivalent in-vehicle time (IVT) units (Wardman, 2001). Each component has a different weight based on user's perception.

For example, it is not the same to travel for 20 minutes sitting than to do so standing in a context of five passengers per square meter, and it is not equivalent to wait and walk 10 minutes in a 20-minute trip than to spend the whole 20 minutes travelling in the vehicle. Table 3.4 shows travel components considered in this study, how we measure them and the IVT equivalence we give them.

Table 3.4. **Level of service attributes considered in the accessibility indicator.**

Component	Measure	Equivalency (IVT)	Source
Waiting time (for a frequency f_c and a headway coefficient of variation CV)	$\frac{1}{2f_c}(1+CV^2)$: expected waiting time including regularity	Multiplicator: 1.6 times (average in UK studies)	Marguier and Ceder, 1984; Wardman, 2001
Travel time	Tv_{p90}: 90th percentile travel time to introduce reliability impacts.	Unit of measurement is IVT	Chen et al., 2003; Pu (2011)
Transfers	Number of transfers	Penalty: 2 to 22 minutes depending on transfer conditions	Currie, 2005; Raveau et al., 2014
Comfort	$\frac{pax}{m^2}$: passenger density inside Metro/bus	Travel time is multiplied by a value between 1 and 2.2, depending on crowding level	Whelan and Crockett, 2009; Tirachini et al., 2013; Batarce et al., 2015

Reported values show that crowding, unreliability and transfers are highly penalised by users. The multipliers and penalties from Table 3.4 are used to calculate an equivalent in vehicle time (IVT) between each origin destination pair of stops, t_{ij}. We use them to build a functional form for the proposed access measure as follows:

$$C_i = \sum_{j\,\in\,\varphi}\sum_{l\,\in\emptyset} F_{ij}(t_{ij}) \cdot C_{ijl} \tag{3}$$

In which:

ij corresponds to each origin destination pair of public transport stops

φ is the set of all public transport stops

$\emptyset$ is the set of all bus services, subway services or combination of both

$$C_{ijl}: \begin{cases} 1 \text{ if there is a bus service, subway line or combination l that connects i with j} \\ 0 \text{ otherwise} \end{cases}$$

and $F_{ij}(t_{ij})$ corresponds to the impedance function introduced in Equation 2.

Attractiveness Land Use Index (ALUI)

Finally, we want to identify the quantity and quality of opportunities and services that can be accessed from a given location. For this we use a methodology inspired on London's case (Cooper et al., 2009), which develops an indicator that measures access to opportunities and essential services (ATOS) by public transport or walk. For this work, we use the number of trips that attracts each transport area by travel purpose (work, education, health, personal visits, recreation and shopping, represented by W_j, E_j, H_j, R_j, V_j *and* S_j divided by the maximum number of trips attracted by a zone to generate a relative attractiveness measure (Equation 4).

$$ALUI_j = \frac{O_j}{max(O_{j\in\varphi})} \; j \in \varphi \qquad (4)$$

$$O_j = W_j, E_j, H_j, R_j, S_j \; or \; V_j$$

This indicator complements the indicators presented before. Furthermore, we use it as a weight in (Equation 3) representing the attractiveness per purpose of each area to visit (Equation 5). If an area has basic services and valuable opportunities, its accessibility indicator should have more weight, while accessibility to a place that has no major attractions, should have no utility for the user.

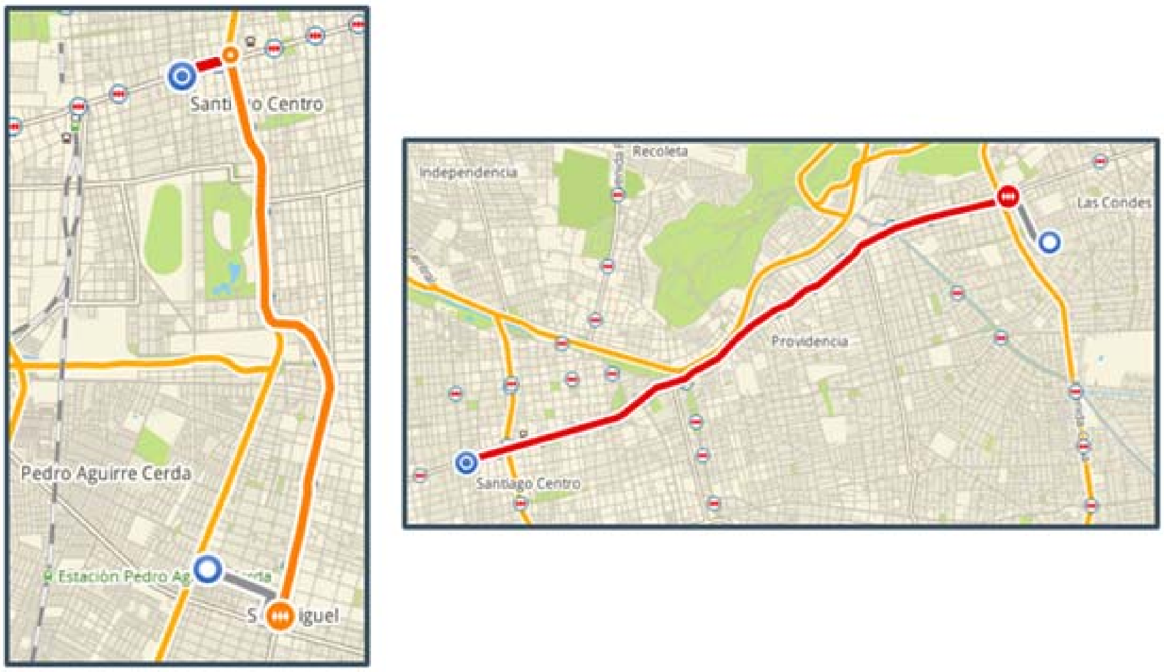
$$C'_i = \sum_{j \in \varphi} \sum_{l \in \emptyset} F_{ij}(t_{ij}) \cdot C_{ijl} \cdot ALUI_j \qquad (5)$$

Case study

The motivation for this exercise is to show the impact of considering the level of service and walking quality on accessibility analysis. Traditional accessibility analysis usually considers only physical accessibility, or equal weight for on-board, waiting and walking time, and does not consider comfort, reliability, regularity and number of transfers.

To show the differences in terms of accessibility and level of service, we analysed a trip to a destination in Santiago's CBD attracting 17.3% of the trips (SECTRA, 2015), concentrating employment, study, health and shopping opportunities. The idea is to compare the three proposed indicators for trips to this destination coming from two communes of different income levels: Las Condes (USD 3 260 per month per household on average) and San Miguel (USD 1 480 per month per household). Both trips include an initial walk and involve the Metro, as described in Figure 3.7.

Figure 3.7. **Route from San Miguel (left) and from Las Condes (right) to Santiago Centro through walk and Metro (Line 2 and Line 1, respectively)**



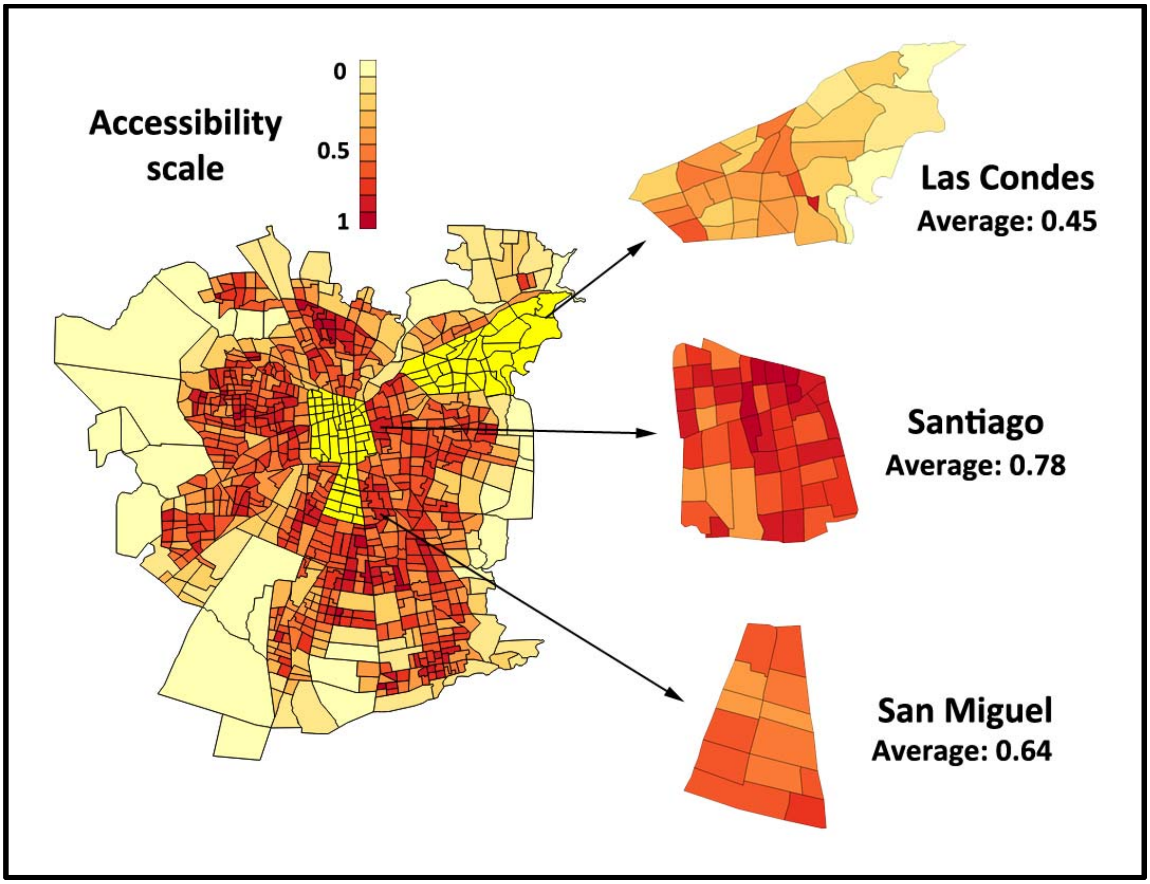
Source: 2GIS (2016))

PAI results

Santiago offers short walking times to public transport stops for most parts of the city. This is consistent with the perception of closeness to public transport reported by 85% of the population of the 35 communes analysed in this study (MINVU, 2010). The nearly 12 000 bus stops in Santiago are part of an extensive network that achieves wide coverage in various sectors, especially in the downtown area.

Figures 3.8 shows PAI values for Santiago and the case study communes of San Miguel, Santiago and Las Condes. As we can see, better PAI is concentrated on the city centre. Las Condes, one of the richest parts of the city, does not have great coverage of public transport despite concentrating a large number of service jobs that are usually performed by captive public transport users who live far from this commune.

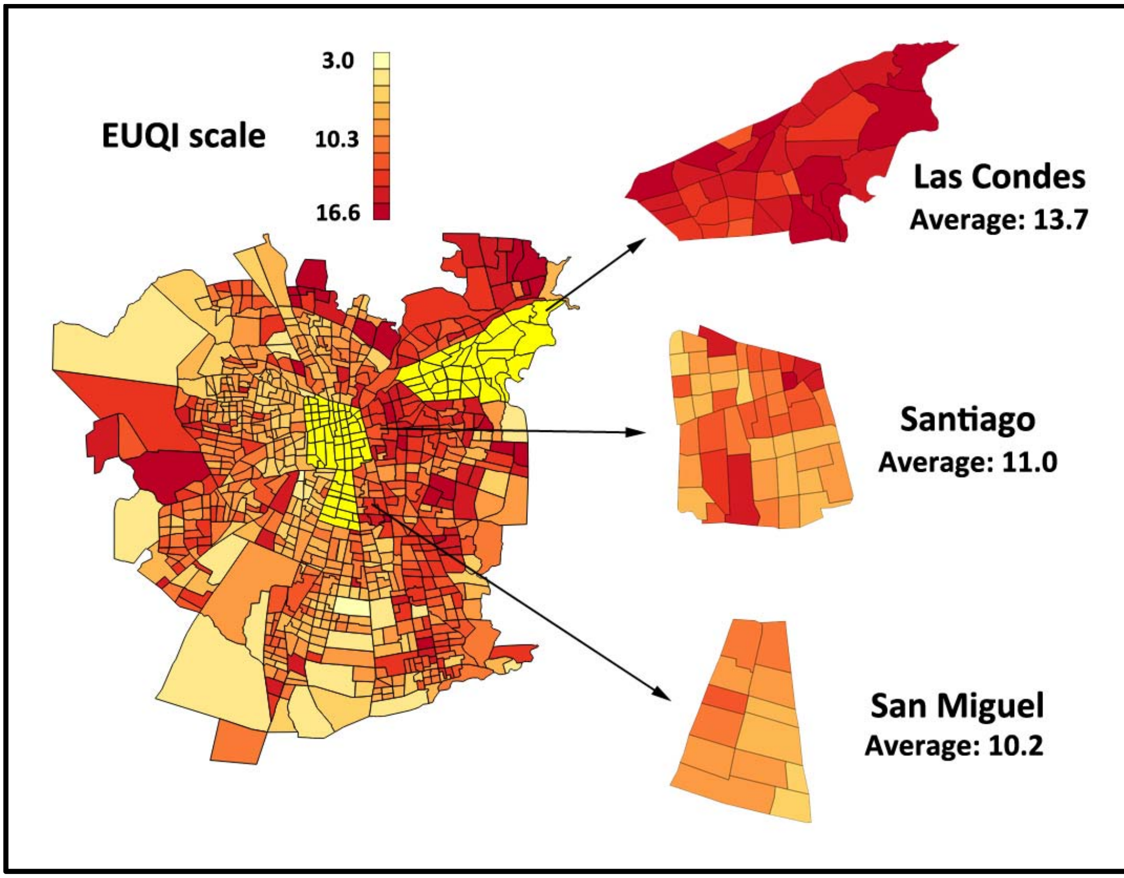
Figure 3.8. **PAI results**



Note: Richards function and v = 3.6 km / hr are used. Scale: 0 (35 minutes on average to 10 nearest stops) to 1 (4 minutes on average to 10 nearest stops). The values are normalized based on the maximum value of access (8.53 of a possible 10 if the location had accessibility 1 to 10 stops nearest).

Meanwhile, Figure 3.9 shows EUQI values for Santiago and case study communes. As expected, better EUQI is concentrated in the eastern sector of the city, corresponding to the high-income area. Thus, although San Miguel has better accessibility and greater public transport modal share than Las Condes (27% vs. 18% based on SECTRA (2015)), the latter has a better standard of urban environment (EUQI) access on the walk. One of the main reasons for this gap is the municipal expenditure per inhabitant per year (USD 562.8 in Las Condes and USD 182.9 in San Miguel) and the financial independence of each commune.

Figure 3.9. **EUQI results**



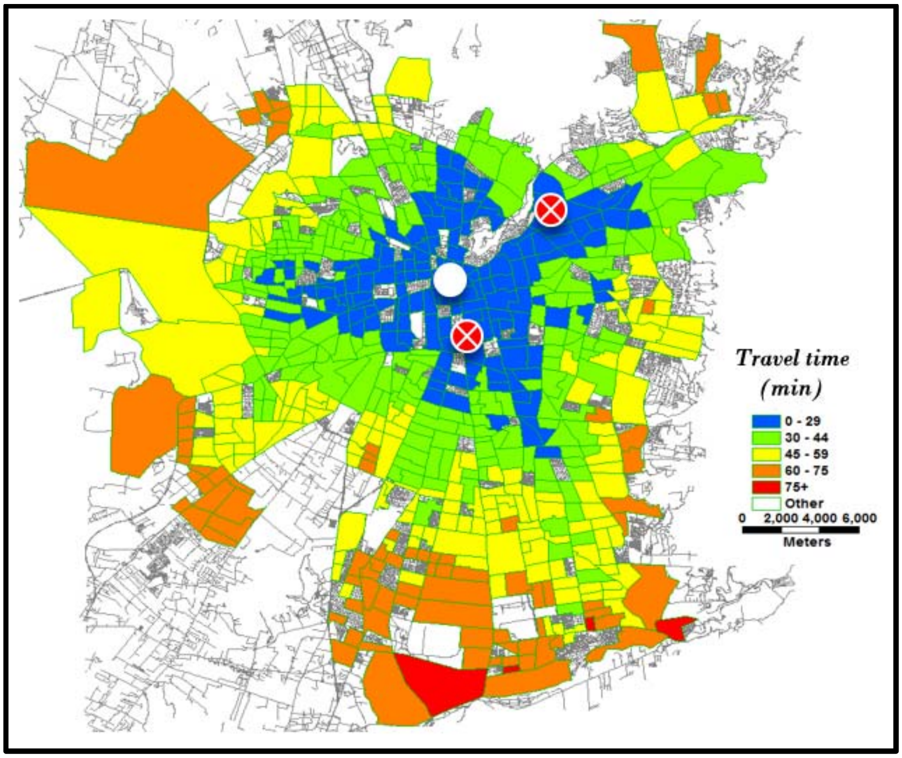
Note: Map is constructed using information from INE (2011), with a maximum value of 19 (see Table 3.2 for more details). We observed that north-eastern areas of the city have a better environment and urban quality, follow by city centre (12.05 score on average, compared to 10.07 from north, south and west sectors).

It is possible to observe that inequality does not only occur between the communes of the case study. Santiago's north-west and south-west sectors have low levels of accessibility to public transport stops and, at the same time, an inferior EUQI. This shows that despite the significant increment in the number of bus stops in Santiago in recent years, this may not be enough. Focus should be placed not only on quantity but also on quality of public spaces around public transport stops.

PTI results

To compute this indicator we calculate a generalised time measure. We want this measure to account not only for travel time, but also transfers, comfort, reliability and regularity. For example, if we account only for in-vehicle travel time, trips to the centre of Santiago look like Figure 3.10.

Figure 3.10. **Total travel times (not including walking, transfers and waiting times) to Santiago Centro (Morning peak, April 2013)**



Note: Red circles with crosses represent starting locations for the case study trips to Santiago Centro (white dot).

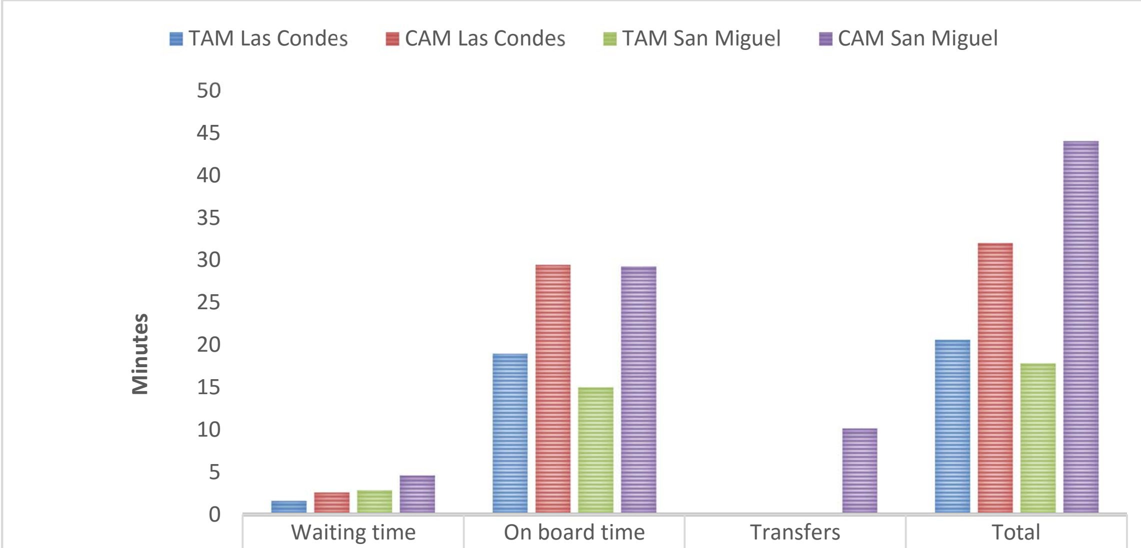
Source: DTPM (2013)

To account for comfort we need a measurement of crowding. Available data (Metro S.A., 2015) describes observed in-vehicle passenger density for trains in each metro line at rush hour (8:15 and 8:30 a.m.). In the case of the trip from Las Condes, the user must travel 14 stations experimenting an average density of 3.28 pax/m^2, meanwhile the trip from San Miguel must travel seven stations on Line 2, experimenting a density of 5.68 pax/m^2. Using crowding multipliers from Tirachini (2015) for standing conditions on the Metro subway system, on board travel time must be multiplied by 1.55 and 1.95 respectively to incorporate user perception.

Regarding waiting time, we used headway information from April 2015 (Metro S.A., 2015). Thus, it was possible to incorporate the headway regularity on user's average waiting time. We used a 1.6 factor from Wardman (2001) to transform waiting time to IVT. In addition, we consider a transfer penalisation from Raveau et al. (2014) for Metro subway system equivalent to 10.2 minutes with average conditions.

Figure 3.11 shows door-to-door time for our case study, comparing the Corrected Accessibility Measure (CAM) with a Traditional Accessibility Measure (TAM) based only on total travel time (formulation on Equation 3 is not calibrated for the entire city yet). The difference in the traditional measure between San Miguel and Las Condes is just 3.26 minutes but, if we account for the level of service, the difference increases to 22.3 minutes. This suggests that the real differences in accessibility levels of different locations can be significantly different when the new attributes are considered, negatively affecting lower income areas therefore having an important impact in equity of travel conditions.

Figure 3.11. **Door-to-door time in our case study**



	Waiting time	On board time	Transfers	Total
TAM Las Condes	1.62	19	0	20.62
CAM Las Condes	2.59	29.45	0	32.04
TAM San Miguel	2.88	15	0	17.88
CAM San Miguel	4.61	29.25	10.2	44.06

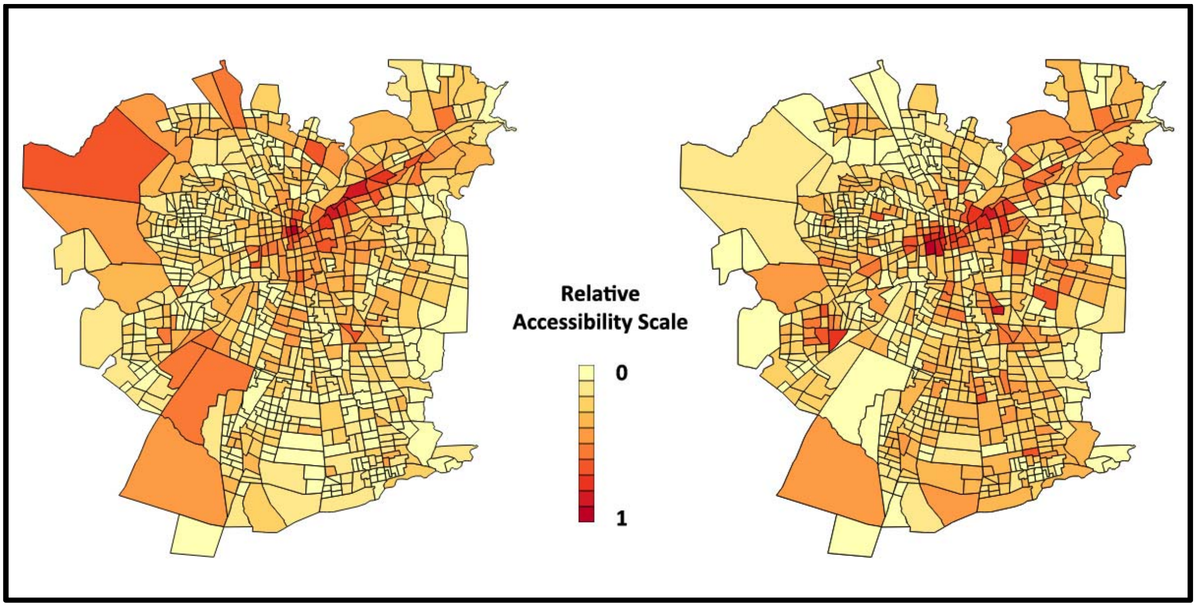
Note: If we consider the level of service perception Corrected Accessibility Measure (CAM), San Miguel increases their access time by 146% regarding Traditional Accessibility Measure (TAM), unlike the 55% from Las Condes. The difference lies mainly in transfer penalty and trip comfort, which has a bad perception from users and affects San Miguel's population.

ALUI results

Since this is just one case study, this example does not reveal the full accessibility to work or study from each starting point, as access to each transport zone is not considered. Since the case study focuses on morning peak hours of a working day, we will focus our analysis on accessibility to work and education, because more than 95% of trips made in this period have these purposes (SECTRA, 2015).

Employment and education attractiveness maps are shown on Figure 3.12. It is important to note that the maps only considers the number of trips attracted by purpose (SECTRA, 2015) and not the travel density, i.e. they are not corrected by the surface of each zone. We note that most attractive zones in terms of education and work are around the centre-east axis called "Alameda-Providencia", the most important avenue of Santiago. We observe that some peripheral locations also have high attractiveness to work, mainly due to industrial activity.

Figure 3.12. **Work attractiveness (left) and education attractiveness (right) using a normalised scale**



The República Metro station, the final location of our case study, is located on the city centre. The specific zone that includes this subway station has a 0.264 relative work attractiveness score, corresponding to the 26th most attractive area between a total of 804 transport zones. Meanwhile, this area corresponds to the largest attractor of study trips across the city, so good accessibility to this sector is crucial to increase educational opportunities given the existence of educational institutes, technical and training centres, universities and schools.

If we want to know how diverse this is zone in terms of opportunities, Shannon's equitability index is an option (TIEM, 2016) (between 0 and 1, with 1 being complete evenness). Although the predominant purposes are work and study with 83.5% of trips, visiting someone and make purchases account for more than 11.5% of the trips, resulting in a 0.645 index value.

It is clear that San Miguel needs to enhance comfort and transfer conditions during the trip, and walk quality in order to improve their access level. Meanwhile, Las Condes needs to increase their access to public transportation stops, because the commune has good public transport level of service and great walk quality. Therefore, this case study is useful to know what kind of measures apply for each particular area given their needs, which it is the main advantage of analysing each indicator separately.

Discussion, conclusions and future work

Santiago has developed and grown without strong land use policies during the last four decades. Lack of integrated land use and transport planning has generated urban segregation that has brought obvious inequalities in terms of access to services. High-income communes have greater proximity to sub-centres that concentrate activities and opportunities, and can provide better infrastructure and public spaces given their budget. This, in turn, makes these communes even more attractive for the location of new activities (mostly commerce and services) and high-quality real estate developments, thus creating a vicious spiral of segregation and concentration of opportunities around high-income areas. One of the main problems with this urban development pattern is the increase in travel time for lower income people, who are usually located in the periphery and are more likely to be captive public transport users.

There is a clear need to improve this situation in Santiago, although this is not a simple problem to tackle. The issue can be approached from two main dimensions: land use and transportation. First, land use policies should focus on avoiding the excessive concentration of activities in high-income areas and on promoting the development of sub-centres that are well distributed across the territory. To achieve this, a metropolitan authority with a large-scale (and long-term) vision for the city and with attributions to define zonings and distribute communal budgets is needed. In addition, social housing policies should have stronger (and clearer) requirements in terms of accessibility to basic services and opportunities in order to improve the inequality gap. This is, however, not easy to define because excessive requirements, that would discourage development of social housing, should also be avoided.

Second, level of service of public transport and a walking quality to public transport stops should be improved. This chapter addresses the aforementioned problem by proposing new and more detailed accessibility indicators and exploring their use as tools to inform decision-making and public transport planning.

Through three proposed indicators, we analyse walking distance to public transport links, the quality of the urban environment, the connectivity of the transport system, the level of service offered by it and the attractiveness of land use. The indicators allow us to identify areas that have greater needs and show where to focus policy efforts and/or infrastructure.

Therefore, the greatest challenge of this work is how to achieve integration and transition to public policy. It is urgent for urban planners and authorities to take care of the transport inequality problem in Santiago and to acknowledge that lack of access to opportunities can intensify this inequality, closely related to social exclusion. In addition to generating robust and rigorous accessibility indicators, these indexes must be able to be easily communicated to relevant authorities and stakeholders. Only in this way, planners and decision makers can use it as an input in transport plans, projects or policies.

In most welfare policies, efficiency and equity appear simultaneously as main objectives. However, there is a clear trade-off between these two objectives, therefore triggering lengthy discussions about how to integrate them in public policy (Le Grand, 1990; Thomopoulos et al., 2009). Murray and Davis (2001) suggest that there is a tendency to focus on issues of economic efficiency in spite of equity. This tendency is why investment and infrastructure priorities are usually determined using CBA methodologies rather than other methodologies, able to account for wider impacts. We suggest that in the case of transport policy and infrastructure projects, CBA is not enough and should be complemented with indicators of accessibility and equity, such as those proposed in this work.

One way to approach this was proposed by Martens et al. (2012), who suggests that the objective of the authorities should be to maximise the average individual accessibility of users, setting a minimum value, sufficient to ensure basic needs. Thus, we should prioritise projects that ensure vertical equity, defined by Litman (2015) as compensation for other social inequalities from different areas of life.

Accessibility and equity indicators should consider the quality of service of public transport and the environment, road network and street furniture. These variables allow us to measure real differences in terms of unequal access to opportunities. For this, we should consider these elements through a corrected measure as proposed, which takes into account the perception of transport users over traditional accessibility measures.

Future work will extend this case study to the entire city of Santiago, in particular the Public Transport Indicator, and analyse what kind of measure is advisable to perform first. This is an interesting question that needs to be addressed from two perspectives: impact and feasibility. It is important to identify which variables, if improved, will have the greatest impact and which are easier to implement. In other words, we propose to identify the actions with the best cost-to-effectiveness ratio. For example, improving transfer conditions of users could be a simpler measure to implement than reducing in-vehicle travel time and, maybe, perceived travel time can be greatly reduced with a relatively small investment in better transfer conditions.

Finally, it is important to address the issue of increase in car use, observable across several cities in Latin America. More and more people leave public transport and become car users, which is worrying from a sustainability point of view. This brings several challenges: first, investigate how to discourage car use to reduce negative externalities and, second, analyse the impact of this trend on the affordability of housing and transportation.

A low level of service in public transport and poor quality of public spaces may trigger a shift from public transport and walking towards the car. Focusing on improving access by public transport and discouraging car use should be a priority in public policy if we want to achieve more equitable cities in terms of access.

References

2GIS (2016), Mapa de Santiago en línea: calles, edificios y empresas de la ciudad. https://2gis.cl/santiago

AVV (2000), NVVP beleidsopties verkend (The National Traffic and Transport Policy: Options Explored), *AVV Transport Research Centre, Rotterdam*.

Batarce, M., Muñoz, J.C., de Dios Ortúzar, J., Raveau, S., Mojica, C. and Ríos, R.A. (2015), Valuing crowding in public transport systems using mixed stated/revealed preferences data: The case of Santiago. In: *Transportation Research Board 94th Annual Meeting* (No. 15-4703).

Betts, J. (2007), “Transport and social disadvantage in Victoria: a government perspective”, in Currie, G., Stanley, J., Stanley, J. (Eds.), *No Way to Go: Transport and Social Disadvantage in Australian Communities*. Monash University Press.

Burns, L.D. (1979), *Transportation, Temporal and Spatial Components of Accessibility*. Lexington Books, Lexington/Toronto.

Chen, C., Skabardonis, A. and Varaiya, P. (2003), “Travel-time reliability as a measure of service”. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 1855, pp. 74-79.

Cheng, Y.H. and Chen, S.Y. (2015), “Perceived accessibility, mobility, and connectivity of public transportation systems”. *Transportation Research Part A: Policy and Practice*, Vol. 77, pp. 386-403.

Cooper, S., Wright, P. and Ball, R. (2009), “Measuring the accessibility of opportunities and services in dense urban environments: Experiences from London”, in *European Transport Conference*.

Currie, G. (2005), “The demand performance of bus rapid transit”, *Journal of Public Transportation,* Vol. 8/1, pp. 3.

Dalvi, M.Q. and Martin, K.M. (1976), “The measurement of accessibility: some preliminary results”. *Transportation*, Vol. 5/1, pp. 17-42.

De Jong, G., Daly, A., Pieters, M. and van der Hoorn, T. (2007), “The logsum as an evaluation measure: review of the literature and new results”. *Transportation Research Part A 41,* Vol. 9, pp. 874–889.

DETR (2000), *Transport 2010. The background analysis*. Department of the Environment, Transport and the Regions, London.

Díaz, G., Gómez-Lobo, A. and Velasco, A. (2006), “Micros en Santiago: de enemigo público a servicio público”, in: Galetovic, A. *Santiago: dónde estamos y hacia dónde vamos*. CEP, Chile.

DTPM (2013), Travel times to Santiago Centro. Based on smart card validations from public transport, www.dtpm.gob.cl/index.php/2013-04-29-20-33-57/matrices-de-viaje

DTPM (2016), Santiago's public transport network. Shapefile.

Geurs, K.T. and Van Wee, B. (2004), "Accessibility evaluation of land-use and transport strategies: review and research directions". *Journal of Transport Geography,* Vol. 12/2, pp. 127-140.

Gonçalves, D.N.S., de Morais Gonçalves, C., de Assis, T.F. and da Silva, M. A. (2014), "Analysis of the Difference between the Euclidean Distance and the Actual Road Distance in Brazil". *Transportation Research Procedia,*Vol. 3, pp. 876-885.

Handy, S.L. and Niemeier, D.A. (1997), Measuring accessibility: an exploration of issues and alternatives. *Environment and planning A,* Vol. 29/7, pp. 1175-1194.

Hansen, W.G. (1959), "How accessibility shapes land use". *Journal of the American Institute of Planners,*Vol. 25/2, pp. 73-76.

Hidalgo, R. (2007), ¿Se acabó el suelo en la gran ciudad?: Las nuevas periferias metropolitanas de la vivienda social en Santiago de Chile. *Revista EURE (Santiago),* Vol. 33/98, pp. 57-75.

INE (2011), National Pre-Census. Government of Chile.

Ingram, D.R. (1971), "The concept of accessibility: a search for an operational form". *Regional Studies,* Vol. 5, pp. 101–107.

Koenig, J.G. (1980), "Indicators of urban accessibility: theory and application". *Transportation,* Vol. 9/2, pp. 145-172.

Kwan, M.P. (1998), "Space-time and integral measures of individual accessibility: A comparative analysis using a point-based framework". *Geographical Analysis*, Vol. 30/3, pp. 191-216.

Le Grand, J. (1990), "Equity versus efficiency: the elusive trade-off". *Ethics*, pp. 554-568.

Lei, T.L. and Church, R.L. (2010), "Mapping transit-based access: integrating GIS, routes and schedule"s. *Int. J. Geogr. Inf. Sci.* Vol. 24, pp. 283–304.

Litman, T. (2003), "Measuring transportation: Traffic, mobility and accessibility". *Institute of Transportation Engineers. ITE Journal*, Vol. 73/10, pp. 28.

Litman, T. (2015), "Evaluating Transportation Equity: Guidance for Incorporating Distributional Impacts in Transportation Planning". *Victoria Transport Policy Institute*.

Lucas, K. (2006), "Providing transport for social inclusion within a framework for environmental justice in the UK". *Transportation Research Part A: Policy and Practice*, Vol. 40/10, pp. 801-809.

Lucas, K., Mattioli, G., Verlinghieri, E. and Guzman, A. (2016), "Transport poverty and its adverse social consequences", in *Proceedings of the Institution of Civil Engineers-Transport*. Thomas Telford (ICE Publishing).

Mamun, S.A., Lownes, N.E., Osleeb, J.P. and Bertolaccini, K. (2013), "A method to define public transit opportunity space". *Journal of Transport Geography,* Vol. 28, pp. 144-154.

Marguier, P.H. and Ceder, A. (1984), Passenger waiting strategies for overlapping bus routes. *Transportation Science*, Vol. 18/3, pp. 207-230.

Martellato, D. and Nijkamp, P. (1998), "The concept of accessibility revisited", in Reggiani, A. *(Ed.), Accessibility, Trade and Locational Behaviour*. Ashgate, Brookfield.

Martens, K., Golub, A. and Robinson, G. (2012), "A justice-theoretic approach to the distribution of transportation benefits: Implications for transportation planning practice in the United States". *Transportation research part A: policy and practice*, Vol. 46/4, pp. 684-695.

Martin, D., Wrigley, H., Barnett, S. and Roderick, P. (2002), "Increasing the sophistication of access measurement in a rural healthcare study". *Health Place,* Vol. 8, pp. 3–13.

Martinez, F.J., (1995), "Access: the transport-land use economic link". *Transportation Research Part B*, Vol. 29/6, pp. 457–470.

Martínez, L.M. and Viegas, J.M. (2013), "A new approach to modelling distance-decay functions for accessibility assessment in transport studies". *Journal of Transport Geography,* Vol. 26, pp. 87-96.

Mavoa, S., Witten, K., McCreanor, T. and O'Sullivan, D. (2012), "GIS based destination accessibility via public transit and walking in Auckland, New Zealand". *Journal of Transport Geography,* Vol. 20/1, pp. 15-22.

MDS (2013), Encuesta de Caracterización Socioeconómica Nacional (CASEN). Ministerio de Desarrollo Social, Gobierno de Chile.

Metro S.A. (2015), Headway and passenger density from trains Metro, April 2015.

MINVU (2010), Quality Perceptions of Urban Life Survey. Adimark GfK and Housing and Urban Studies Advisory Commission. Government of Chile.

MINVU (2012), Documentos Sector Vivienda. Seremi Región Antofagasta. http://documentos.minvu.cl/regionii/seremi/resoluciones_exentas/documentos/res_ex_991_12.pdf

Muñoz, J.C. and Gschwender, A. (2008), "Transantiago: A tale of two cities". *Research in Transportation Economics,* Vol. 22/1, pp. 45-53.

Muñoz, J.C., Batarce M. and Hidalgo, D. (2014), "Transantiago, five years after its launch". *Research in Transport Economics*, Vol. 48, pp. 184-193.

Murray, A.T. and Davis, R. (2001), "Equity in regional service provision". *Journal of Regional Science*, Vol. 41/4, pp. 557-600.

Neutens, T., Schwanen, T., Witlox, F. and De Maeyer, P. (2008), "My space or your space? Towards a measure of joint accessibility". *Computers, Environment and Urban Systems*, Vol. 32/5, pp. 331-342.

Niehaus, M., Galilea, P. and Hurtubia, R. (2015), Accesibilidad y equidad: ampliando la caja de herramientas para la planificación en transporte. *Proceedings of the XVII Congreso Chileno de Ingeniería de Transporte*, Concepción, Chile, 13-15 October 2015.

OECD (2015), *In It Together: Why Less Inequality Benefits All*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789264235120-en

Páez, A., Scott, D.M. and Morency, C. (2012), “Measuring accessibility: positive and normative implementations of various accessibility indicators”. *Journal of Transport Geography*, Vol. 25, pp. 141-153.

Pu, W. (2011), “Analytic relationships between travel time reliability measures”. *Transportation Research Record: Journal of the Transportation Research Board,* Vol. 2254, pp. 122-130.

QGIS Development Team (2016), QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org

Raveau, S., Guo, Z., Muñoz, J.C. and Wilson, N.H. (2014), “A behavioural comparison of route choice on metro networks: Time, transfers, crowding, topology and socio-demographics”. *Transportation Research Part A: Policy and Practice*, Vol. 66, pp. 185-195.

Rivera, A. (2012), Historia de la política habitacional en el área Metropolitana de Santiago. *Revista CIS 16*, pp. 27-44.

Rodríguez, J. (2008), “Movilidad cotidiana, desigualdad social y segregación residencial en cuatro metrópolis de América Latina”. *EURE (Santiago),* Vol. 34/103, pp. 49-71.

Sabatini, F., Wormald G., Sierralta C. and Peters, P.A. (2009). “Residential Segregation in Santiago: Scale-Related Effects and Trends, 1992–2002”. *Urban Segregation and Governance in the Americas*. B. R. Roberts and R. H. Wilson. New York, US, Palgrave Macmillan: p. 244.

SECTRA (2015), O-D Survey from 2012. Planning and Development Coordination, Transport and Telecommunications Ministry, Government of Chile.

Thomopoulos, N., Grant-Muller, S. and Tight, M.R. (2009), “Incorporating equity considerations in transport infrastructure evaluation: Current practice and a proposed methodology”. *Evaluation and Program Planning*, Vol. 32/4, pp. 351-359.

TIEM (2016), Diversity Indices: Shannon’s H and E. The Institute for Environmental Modeling, The University of Tennessee, Knoxville. www.tiem.utk.edu/~gross/bioed/bealsmodules/shannonDI.html

Tirachini, A. (2015),” Six passengers per square meter: Effects of crowding on the wellbeing of passengers and public transport supply”. *IDB Transport Week*, Mexico City, September 2015.

Tirachini, A., Hensher, D.A. and Rose, J.M. (2013), “Crowding in public transport systems: effects on users, operation and implications for the estimation of demand”. *Transportation research part A: Policy and Practice*, Vol. 53, pp. 36-52.

Van Wee, B., Hagoort, M. and Annema, J.A. (2001), “Accessibility measures with competition”. *Journal of Transport Geography,* Vol. 9/3, pp. 199-208.

Wardman, M. (2001), "A review of British evidence on time and service quality valuations". *Transportation Research Part E: Logistics and Transportation Review,* Vol. 37/2, pp. 107-128.

Whelan, G. and Crockett, J. (2009), "An investigation of the willingness to pay to reduce rail overcrowding", in *Proceedings of the first International Conference on Choice Modelling*, Harrogate, England

Chapter 4
Housing plus transportation affordability indices: Uses, opportunities, and challenges

Erick Guerra
Assistant Professor of City and Regional Planning, University of Pennsylvania, United States

Mariel Kirschen
Master's Student in City and Regional Planning, University of Pennsylvania, United States

This chapter provides an overview of the Center for Neighborhood Technology's (CNT) H+T affordability index and its potential application outside of the United States (US), where it has played a prominent role in documenting the relationship between housing and transportation and in influencing local and national housing policies. After describing the index and its policy use, we detail some of the challenges and opportunities of applying the index in Mexico, apply a modified H+T index to the Mexico City metropolitan area, and examine the effect of accounting for transportation costs on maps and measures of housing affordability.

Finally, we conclude with a discussion of some of the opportunities and challenges of applying the H+T index in other OECD nations. The objective is to develop a better understanding of how an H+T index or similar tool could lead to improved public policy throughout the OECD.

Introduction and overview

This technical paper provides an overview of the Center for Neighborhood Technology's (CNT) H+T affordability index and its potential application outside of the United States (US). The H+T index incorporates transportation costs into measures of neighbourhood affordability and maps these relationships across US metropolitan areas. The central motivation for the index is to encourage more centralized housing development and discourage urban sprawl. According the index's supporters, the failure to account for the higher transportation costs in remote neighbourhoods has led to policies, plans, and regulations that exacerbate sprawl and locate households far from civic, social, and economic amenities and opportunities. It also may harm families: After housing, transportation costs absorb the largest share of American households' income.

The relationship between transportation and housing costs is well-known and central to theories and models of urban form, suburbanization, and housing markets (Alonso 1960, 1964, Muth 1969, Mills 1972, Brueckner 1987). It also features in popular explanations of American real estate markets: households drive far enough out from an urban centre until they can qualify for a home mortgage. Transit plays a particularly prominent role in where transit-using households choose to live (Cervero 2007) and may help explain part of why poor American households tend to concentrate in cities (Glaeser et al. 2008). Put simply, households often make trade-offs between how much they spend on housing and how much they spend on transportation.

This well-established relationship has led researchers, advocates, and policy makers to argue that measures of neighbourhood affordability ought to incorporate the costs of transportation as well as the costs of housing (Bogdon and Can 1997, Belsky et al. 2005, Jewkes and Delgadillo 2010). It has also resulted in a number of policies to try to encourage more generous mortgages and the construction of more affordable housing construction in areas with good transit access and lower average transportation costs. The CNT's H+T index has played a prominent role in documenting the relationship between housing and transportation and in influencing local and national housing policies.

Throughout the remainder of this chapter, we describe the H+T index, its policy uses, and its critiques in greater detail. We then describe some of the challenges and opportunities of applying the index in Mexico, apply a modified H+T index to the Mexico City metropolitan area, and examine the effect of accounting for transportation costs on maps and measures of housing affordability. Finally, we conclude with a discussion of some of the opportunities and challenges of applying the H+T index in other OECD nations. The objective is to develop a better understanding of how an H+T index or similar tool could lead to improved public policy throughout the OECD.

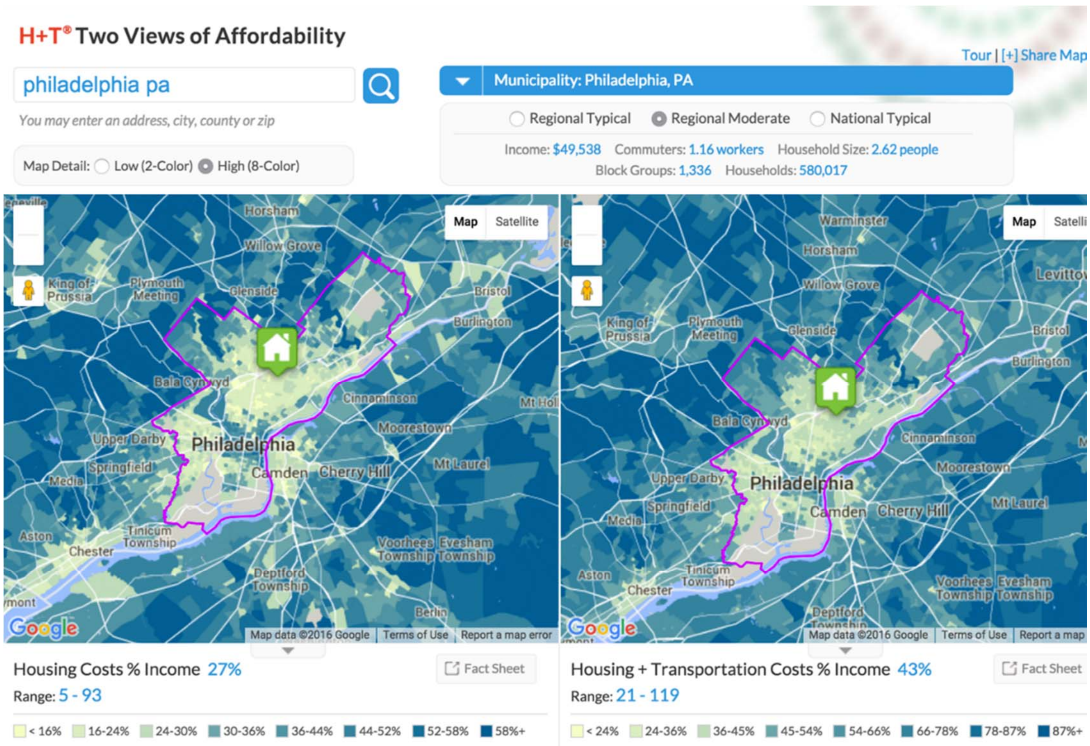
The housing plus transportation index

The H+T index provides an estimate of the typical cost of housing and transportation in different neighbourhoods and compares this estimate to a household or typical household's income. The CNT deems a neighbourhood affordable if a given household would spend 45% or less of its income on housing and transportation costs. This number accounts for an existing rule of thumb that households should spend 30% or less of their income on housing and adds another 15% for transportation costs. (According to the national consumer expenditure survey, American households spend an average of 18% of their income on transportation.)

$$H + T\ Index = \frac{Housing\ Costs + Transportation\ Costs}{Income}$$

On its website, the CNT provides an interface to map neighbourhood affordability for a typical household earning the metropolitan median income in 917 US metropolitan and micropolitan areas. Figure 4.1 shows the results of the online map for the Philadelphia region. Areas shaded in dark blues are increasingly less affordable, while lighter greens are increasingly more affordable. Accounting for transportation costs (the map on the right) instead of just housing costs (the map on the left), suburban neighbourhoods become relatively less affordable to a median-income household. However, the overall geography of affordability does not change much. Other regions, such as St. Louis, experience notable changes in the geography of affordability when accounting for transportation costs. Specifically, suburban neighbourhoods become substantially less affordable.

Figure 4.1. **CNT's default online affordability maps for Philadelphia and surrounding counties**



Source: Center for Neighborhood Technology's Affordability Comparison Maps (http://htaindex.cnt.org/compare-affordability/)

Estimating transportation costs

The primary contribution of the CNT's affordability index is the estimation of typical transportation costs in different neighbourhoods. Building on earlier work from a 1994 Natural Resources Defense Council study (Holtzclaw et al. 2002), the CNT estimates models of car ownership, vehicle miles travelled (VMT), and transit expenditures using multivariate ordinary least squares regression. Table 4.1 lists the three independent variables and the predictor variables to estimate each one. Appendix A provides additional details on the 13 publicly available data sources CNT uses to estimate travel expenses for the H+T affordability index. The national Census and American Community Survey provide the data on median household income and median housing prices and rents by Block Group (600 to 3 000 people) and Census Tract (1 200 to 8 000 people).

Table 4.1. **Data and sources used to predict car ownership, car use, and transit use**

Prediction	Source	Predictors
Auto Ownership	2013 ACS	Fraction of single family detached housing
		Commuters per household
		Transit connectivity index
		Median household income
		Gross household density
		Employment Mix
		Household Size
		Regional Household Intensity
		Block Density
		Employment Gravity
Auto Use (VMT)	Odometer readings in IL from 2010-2012	Fraction of Single family detached housing
		Average Available Transit Trips per Week
		Commuters/Household
		Gross Household Density
		Regional Household Intensity
		Transit connectivity index
		Median household income
		Average Household Size
		Employment Access Index
		Transit Access Shed
Transit Use	2013 ACS	Regional Household Intensity
	(% public transportation commuters)	Transit Connectivity
		Employment Access Index
		Employment Mix Index
		Fraction of single family detached housing
		Transit Access Shed
		Transit Access Shed Jobs
		Median Household Income
		Average Available Transit Trips per Week
		Average Household Size

Source: Center for Neighborhood Technology's 2015 H+T Methodology Document (accessed 1/25/2016)

The tool then applies the results of the model to estimate typical car ownership, car use, and transit use within and across neighbourhoods and regions using publicly available data. The predictive model uses regional rather than local socioeconomic data to estimate local VMT, car ownership, and transit use to estimate at the likely expenses for a typical regional household rather than a typical local household. Finally, the CNT multiplies these predicted figures by the expected costs of car ownership, car use, and transit use to arrive at the final estimate of transportation costs:

$$Household\ T\ Costs = [C_{AO} * F_{AO}(X)] + [C_{AU} * F_{AU}(X)] + [C_{TU} * F_{TU}(X)]$$

where:

C is the cost factor (i.e. dollars per mile)

F is a function of the independent variables F_{AO} is auto ownership, F_{AU} is auto use, F_{TU} is transit use).

Car ownership and vehicle travel costs

The CNT estimates the cost of car ownership and VMT using 2013 inflation-adjusted data from the 2005 – 2010 Consumer Expenditure Survey. Because wealthier households tend to own more expensive cars with different operating costs than poorer households, the CNT takes the average costs per vehicle for five income groups (those earning USD 0-20 000; 20 000-40 000; USD 40 000-60 000; 60 000 – 100 000; and 100 000 and above). For the affordability index, it applies the costs of vehicle ownership to one of the five groups, depending on the regional median income. For example, households in greater Philadelphia had a 2013 median income of USD 49 538, so the index applies the average cost per vehicle of households earning between USD 40 000 and 60 000 from the Consumer Expenditure Survey. To estimate costs per vehicle mile of travel, the CNT matches total transportation expenditures by the five income groups to estimates of vehicle travel for those groups. Unlike the model of car ownership and transit use, which use nationally available date, the model of vehicle travel relies on odometer readings from Illinois drivers in the Chicago and St. Louis metropolitan areas from 2010 to 2012.

Transit costs

To estimate transit costs, the CNT matches metropolitan areas to data from the 2013 National Transit Database (NTD), which includes estimates of total miles of passenger travel (PMT), unlinked passenger trips (UPT), and total fare revenues. Because the geographies of the two datasets do not match, the CNT also estimates the proportion of fare revenues that come from each county within a transit agencies jurisdiction, based on the proportion of total transit stations that fall within a county from publicly available General Transit Feed Specification (GTFS) feeds. County-level fare revenues are then applied to block groups based on the proportion of total county commute trips (taken from the ACS) that originated from each block group. In counties that do not have GTFS feeds, the CNT uses national averages. Finally, the CNT estimates average transit expenditures as the total amount of fare revenues assigned to a block group divided by the number of households in that block group.

H+T and public policy

Since its inception, the H+T index's emphasis has been to encourage more housing development in areas that have higher land prices but lower transportation costs. Box 4.1 summarizes some of the ongoing uses of the H+T that the CNT describes on its website. These range from policies designed to increase the availability of public housing around transit to tools to help analyse where to invest in new transit. Of particular note, the national Department of Housing and Urban Development and Department of Transportation worked with the CNT to create an online location affordability index and transportation cost calculator as part of a larger national Sustainable Communities Initiative (US Department of Housing and Urban Development 2016). These tools are designed to help policy makers and individual households make informed decisions about where to encourage development, where to live, and how much transportation is likely to cost in a given neighbourhood or home. The Sustainable Communities Initiative also provides grants to cities and regions in order to encourage transit-oriented development, affordable housing construction, and sustainable development.

Box 4.1. **Sample of users of the CNT's H+T affordability index (CNT 2015)**

Planners

- Chicago - Metropolitan Panning Council (MPC) used H+T index data in a "corridor selection analysis" to determine potential BRT locations
- Chicago Metropolitan Agency for Planning (CMAP) used suggested H+T index standard as their livability measure in their GO TO 2040 comprehensive regional plan.
- Ohio –Living Cities sponsored the CNT and the Ohio Governor's office to utilize the tool for suggestions for state urban revitalization strategies to reduce cost of living in Cincinnati, Cleveland, and Columbus.
- Washington, DC – Office of Planning worked with CNT on a custom H+T index that integrated market-rate housing costs and local land-use and transit network data.

Housing professionals

- Minneapolis-St.Paul; Washington, DC; Boston; San Francisco Bay Area – Partnered with the Urban Land Institute (ULI), CNT developed customized calculators that could both compare neighbourhood costs and direct transportation choices.
- Santa Fe, NM – Local housing non-profit uses a tailored Index platform to inform prospective homeowners about location efficiency and how to manage transportation costs in order to save for homeownership.
- San Francisco, CA – The Metropolitan Transportation Commission (MTC) gave credit to the Index for the establishment of the Bay Area Transit Oriented Affordable Housing Fund.
- Center for Housing Policy – Research with CNT concerning struggles of moderate-income households to tackle hidden factors that threaten affordability of housing and transportation.

Policy makers

- Department of Housing and Urban Development (HUD) - Sustainable Communities Initiative grants to support sustainable development projects.
- State of Illinois – The 45% affordability measure adopted into law with bipartisan support to be used by five government agencies for both financing and siting decisions.
- El Paso, TX – City Council adopted 50% H+T affordability standard for City funding and policy decisions.

Affordability rankings

The H+T index can also help paint a substantially different picture of which parts of the country are most affordable or expensive. These types of lists feature frequently in news stories and public policy dialogues, but rarely feature transportation costs. Table 4.2 provides a list of cities by how affordable they are to a typical household in that region when ignoring and considering transportation costs. Washington D.C. is the most affordable city to its typical residents when accounting for transportation as well as housing costs, but only the 8th most affordable when ignoring transportation costs. Other cities like Cincinnati and Detroit are decidedly less affordable when considering transportation costs.

Table 4.2. **Affordability rankings for major US cities and metropolitan areas**

Moderate-Income Housing and Transportation Burden								
MUNICIPALITY	**% Housing Rank**	**% Housing + Transportation Rank**	**Change in Rank After Adding Transportation**		**CMSA**	**% Housing Rank**	**% Housing + Transportation Rank**	**Change in Rank After Adding Transportation**
Washington	8	1	-7		Washington	4	1	-3
Baltimore	1	2	1		Minneapolis	1	2	1
Philadelphia	6	3	-3		Baltimore	9	3	-6
Boston	12	4	-8		Boston	16	4	-12
Minneapolis	7	5	-2		Denver	6	5	-1
NYC	17	6	-11		Seattle	13	6	-7
St. Louis	3	7	4		Philadelphia	15	7	-8
Cincinnati	2	8	6		San Francisco	18	8	-10
Pittsburgh	5	9	4		Cincinnati	2	9	7
Detroit	4	10	6		Pittsburgh	3	10	7
Denver	10	11	1		St. Louis	5	11	6
San Francisco	20	12	-8		Dallas	7	12	5
Chicago	15	13	-2		Detroit	12	13	1
Dallas	11	14	3		NYC	22	14	-8
Seattle	16	15	-1		Houston	8	15	7
Houston	9	16	7		Chicago	17	16	-1
Sacramento	13	17	4		Portland	14	17	3
Portland	18	18	0		Atlanta	10	18	8
Atlanta	19	19	0		Phoenix	11	19	8
Phoenix	14	20	6		Sacramento	19	20	1
Miami	21	21	0		San Diego	23	21	-2
Los Angeles	24	22	-2		Los Angeles	24	22	-2
San Diego	25	23	-2		Tampa	20	23	3
Riverside	22	24	2		Riverside	21	24	3
Tampa	23	25	2		Miami	25	25	0

Source: Table generated by authors using data from the Center for Neighborhood Technology's website

Affordable housing and mortgage policies

Lastly, the H+T index has influenced public policies about where to site of subsidized housing developments and how much to lend households to buy a home. Perhaps its largest influence has been through the Low-Income Housing Tax Credit, the largest source of funding for constructing and maintaining subsidized housing in the US. This program requires that states develop and manage a competitive allocation process to determine which sites and developers receive federal funds. A number of states—notably California, Massachusetts, Colorado, Minnesota, New Jersey, Illinois, Louisiana, Nevada, New Mexico, and Virginia—give priority to projects that are suited near transit or have good accessibility to job centres and other amenities (Governors' Institute n.d., Texas Department of Housing and Community Affairs 2010, Smart Growth America 2016). Other state and local programs, such as California's Transit Oriented Development (TOD) Housing Program and the Bay Area's Transportation for Livable Communities initiative provides subsidies to build or purchase housing units near transit (Renne 2008, California Department of Housing and Community Development 2015).

Beginning in the late 1990s, the Federal National Mortgage Association (Fannie Mae) developed and promoted the location-efficient and smart commute mortgage programs. The intention was to allow homeowners to access larger loans in areas with lower commuting costs and thereby reduce auto use, support transit use, increase the supply of housing near transit, and increase homeownership among low- and moderate-income households. Despite initial interest, lenders only used the program to make around 300 loans and the program closed in 2008 due to a lack of lender interest (Chatman and Voorhoeve 2010). This lack of interest stemmed at least partially from some of the theoretical and technical challenges of applying an H+T index to inform housing policy.

Challenges and critiques of the H+T index

For all its benefits and policy uses, several challenges limit the use and applicability of the H+T in the US and its transferability to other countries.

Affordability

One of the biggest challenges of the H+T index is that the concept of affordability is somewhat arbitrary. Early measures and popular expressions of affordability considered housing affordable if it absorbed roughly 25% of income, which came from a popular expression: a week's wages for a month's rent (Feins and Lane 1981). In 1969, Congress gave legal weight to this affordability concept through the Brooke Amendment. The amendment capped the amount that any family would spend on housing at 25% of household income with some variation based on other household characteristics. In 1983, the Housing and Urban-Rural Recovery Act increased and simplified the affordability standard to 30% for all households (Pelletiere 2008). HUD publishes affordability guidelines that vary by region and household size that are used to determine eligibility for subsidized housing and the public merit of affordable housing developments (US Department of Housing and Urban Development 2016).

Although easy to calculate and compare across regions (Bogdon and Can 1997), researchers and advocates have criticized the measure for more than just its exclusion of transportation costs. These criticisms extend to the H+T index:

1. Affordability thresholds qualify something that is inherently quantitative in nature. A household hold that spends 31% of its income on housing is not substantially more burdened than one that spends 29% on housing. Yet the notion of affordability treats these two households similarly to households than spend 50% and 15% of their respective income on housing.

2. Affordability indices do not consider household size, age, or composition (Bogdon and Can 1997, Belsky et al. 2005, Jewkes and Delgadillo 2010). A family with only working-age member and several school children will likely find it more burdensome to spend 30% of income on housing, yet likely needs a larger house than a single-person household with an income.

3. In addition to housing and transportation costs, other important expenditures like schools and food vary substantially within and across regions (Tegeler and Chouest 2010). In practice this may tend to offset some of the effects of the H+T index. For example, a household in the suburbs may spend money to drive to a large grocery store with lower priced goods. Schooling costs almost certainly play a large role in household expenditures as well. For example, a household may prefer to send their kids to free public schools in a suburban school district, but would choose to send them to an expensive private school if the public school is in a poorly performing urban district.

4. Indices ignore household preferences. Some households are willing to pay more for a larger or high-quality house, while others might prefer to conserve housing expenditures in order to spend more on other items like food, transportation, or entertainment.

5. By focusing on income, the indices ignore life-stage considerations, accumulated wealth, and debt. For example a young household may elect to spend a significantly higher portion of income on housing in the expectation of future earnings. Many university students and recent graduates experience high rent burdens but are financially and socially quite privileged. At the other end of the spectrum, an elderly household spending 30% of income on housing might be extremely burdened, since houses are the largest source of wealth for most households and elderly households often rely on this accumulated wealth in retirement.

Aggregation bias

At its heart, affordability affects individuals not census block groups, cities, or metropolitan areas. A homogenous neighbourhood where all housing costs the median price is likely much less affordable than a diverse neighbourhood with the same median housing cost but substantial variation in housing costs. The same holds true for cities and regions. In fact, households may prefer to live in neighbourhoods with higher median housing costs, provided that they can find a single affordable house or apartment. What matters is not the median income or housing price, but the distribution of income and housing prices along with ability to match houses and apartments to those that can afford them. By lumping all incomes and housing costs into a single median measure, the index fails to account for this important component of affordability. This type of aggregation bias is common when indices fail to analyse the correct unit of analysis, but instead aggregate up to a larger geographic area.

The aggregation of transportation expenses is perhaps even more problematic since there is so much variation and potential variation in how much a household spends on transportation. For example, a household where every member drives to all destinations would spend substantially more than an otherwise identical household that carpooled or used transit. Some neighbourhoods may be affordable for transit users, but not for car owners with the same income.

Even across individuals, there is a temporal component to housing and transportation affordability. For example, transportation costs almost certainly vary with job location as well as housing location. Changing jobs could substantially influence how much a household spends on transportation and thus how much it can afford to spend on housing. This temporal uncertainty helped contribute to lenders' lack of interest in Fannie Mae's location-efficient and smart commute mortgage programs (Chatman and Voorhoeve 2010).

VMT estimate

The CNT uses odometer readings and built environment data from a single region to estimate car use for the rest of the country in its H+T estimates. There is, however, significant variation in built environments, travel behavior, and probably also the empirical relationship between the two throughout the country. The CNT argues that this is not a problem because the Illinois data include a variety of built environments from rural areas and large cities. Although there are substantial commonalities across many studies examining the relationship between the built environment and vehicle travel (Ewing and Cervero 2010), whether the model estimates are applicable to other regions remains an open question. The existing model is not suitable for other OECD nations, where car ownership and use tend to be more expensive than in the US.

The high cost of new construction

Constructing new housing in transit-friendly areas is one of the CNT's recommendations based on the H+T Index. However, new construction by its nature is expensive and, unless highly subsidized, unaffordable to most households. Furthermore, land prices and housing values frequently increase with proximity to transit (Knapp 2001, Cervero and Duncan 2002, Rodríguez and Targa 2004, Debrezion et al. 2007, Hess and Almeida 2007, Kahn 2007, Cervero and Kang 2009). Since wealthy households are more likely to opt for a combination of new construction and car ownership, building market rate housing around transit is unlikely to reduce H+T expenditures for vulnerable households.

Fair housing critique

One argument against the use of H+T measures to help determine where to locate affordable housing is that it may encourage concentration of poverty (Tegeler and Chouest 2010). This argument is particularly poignant in the US, where a history of racist housing discrimination has contributed to concentrations of poor and non-white households in specific neighbourhoods, often in central neighbourhoods with good transit access. This fair housing critique against place-based affordable housing development recently came to a head with a ruling by the Supreme Court in the case of Texas Department of Housing & Community Affairs v. Inclusive Communities Project, Inc. (for an overview of the ruling, see Epstein et al. 2015). The Supreme Court ruled 5-to-4 that the Texas Department of Housing & Community Affairs was in violation of the Fair Housing Act (Title VIII of the Civil Rights Act of 1968) based on arguments that affordable housing allocations perpetuated and strengthened existing patterns of racial and socioeconomic segregation. Unless carefully implemented, policies to increase the development of affordable housing or extend credit to low income households around transit will tend to increase socioeconomic and racial segregation and in some cases may even be in violation of federal law.

Housing plus transportation index in Mexico City metropolitan area

How readily could a housing and transportation affordability index be applied to Mexico and Mexico City? While household expenditure data are readily available from the annual consumer expenditure survey (INEGI 2016), the decennial census does not provide information on household income or vehicle ownership (since 2000, the census asks where a household owns one or more vehicle, but not how many). Furthermore, spatially refined data on vehicle travel are sparse, though estimable for Mexico City (Guerra 2014a) using a 2007 household travel survey (INEGI 2007). With four times the population of the next largest urban agglomeration and the most robust public transportation network, however, Mexico City's residents' travel behavior likely vary substantially from residents of other regions.

This section applies the housing plus transportation affordability index to the Mexico City metropolitan area (Zona Metropolitana del Valle de México, henceforth referred to as "Mexico city"). Given that most households rely on public transportation and driving accounts for under a third of trips, we limit the analysis to non-driving households from the 2007 household travel survey. This excludes wealthier households, who are the most likely to drive, but emphasizes poorer households who are most constrained by a lack of affordable housing or transportation options. Note that we aggregate the results to the metropolitan area's 76 boroughs and municipalities rather than census tracts (Agebs). This produces clearer maps and avoids the problem of insufficient samples in many of the region's 5 000 census tracts. Box 4.2 summarises a similar exercise conducted in Qom, Iran.

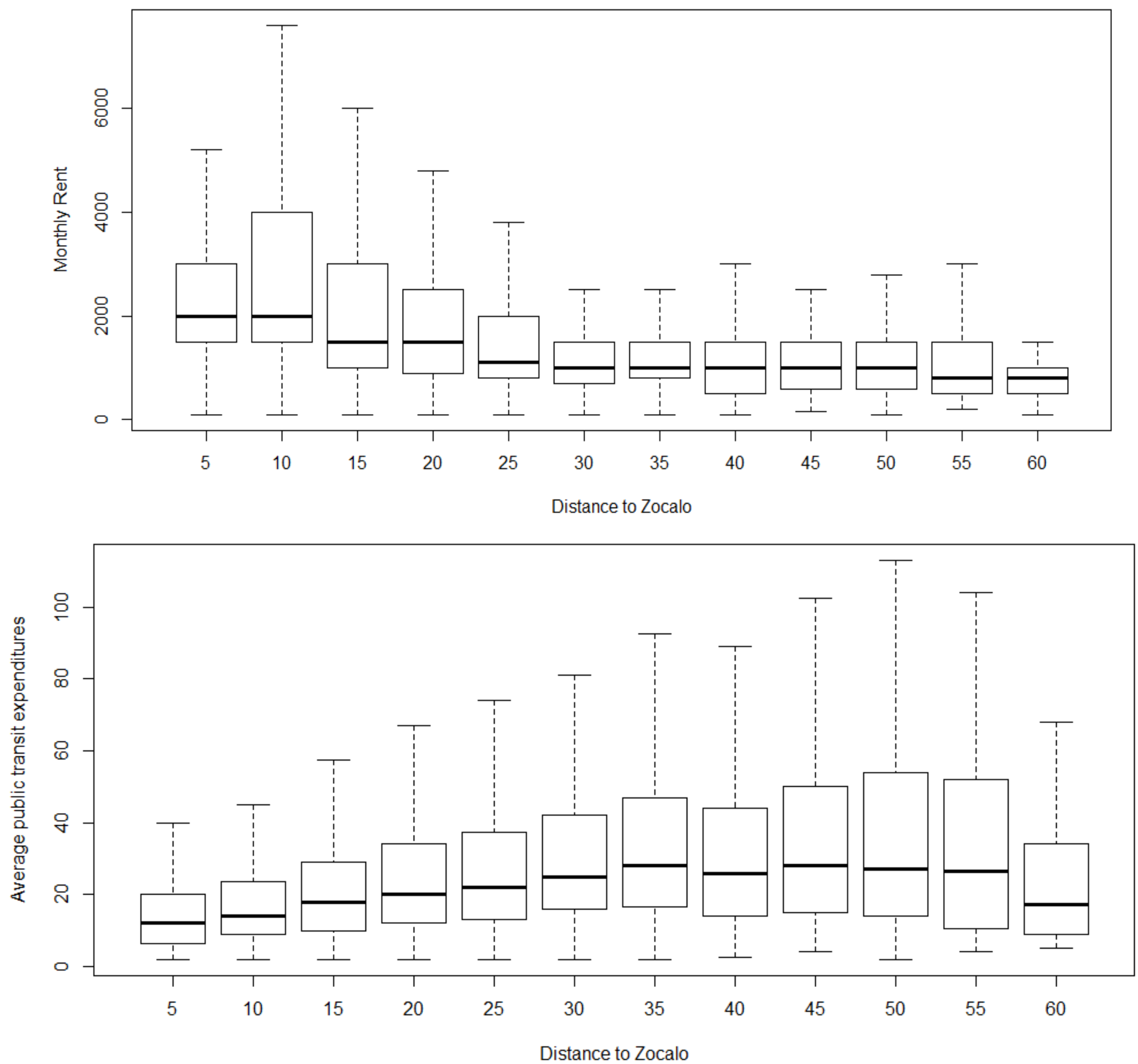
Box 4.2. **Applying an H+T Index in Qom, Iran**

Unaffordable housing is a growing concern in many developing-world cities, where rapid population growth, insufficient infrastructure, and shrinking household sizes have led to substantial increases in housing and transportation prices. Isalou et al (2014) conducted a study in Qom, Iran, to evaluate the usefulness and findings of the H+T index in a developing-world context. Unlike in the US, the authors relied on a survey to collect data about household characteristics, travel behavior, transportation expenditures, and housing costs. In Qom, a typical suburban household spends 57% of their monthly income on housing and transportation, compared to 45% for a centrally located household. As in the US and Mexico City, accounting for travel expenditures increases the affordability of urban neighbourhoods relative to suburban ones.

Rents and transit expenditures in Mexico City

The average non-driving household spends an estimated 33% of income on rent and 15% of income on transit expenditures in Mexico City (authors' estimates using (INEGI 2007)). This suggests that the Center for Neighborhood Technology's measures of rent and transportation burden are at least somewhat transferable to this metropolitan area. Across the metropolis, monthly rents decrease with distance from the urban centre (measured here as the network distance to the central Zocalo) while transit expenditures increase. Figure 4.2 plots households' transit expenditures and monthly rents by 5 kilometre increment from the Zocalo. Although median household transit expenditures increase with distance into the most remote neighbourhoods, the rent gradient flattens at around 20 kilometres from the centre. Beyond this point increase in travel costs do not appear to correlate with reductions in transit expenditures. Finally, it is important to note that incorporating car ownership and use into travel expenditures would tend to increase central households' transportation expenditures more than peripheral households' expenditures. In Mexico City, as in much of the world, wealthier households tend to choose both central housing locations and cars (Guerra 2015a). Peripheral neighbourhoods are generally poorer and more transit reliant.

Figure 4.2. **Boxplots of monthly rent and public expenditures by 5-kilometre increment from the central Zocalo**

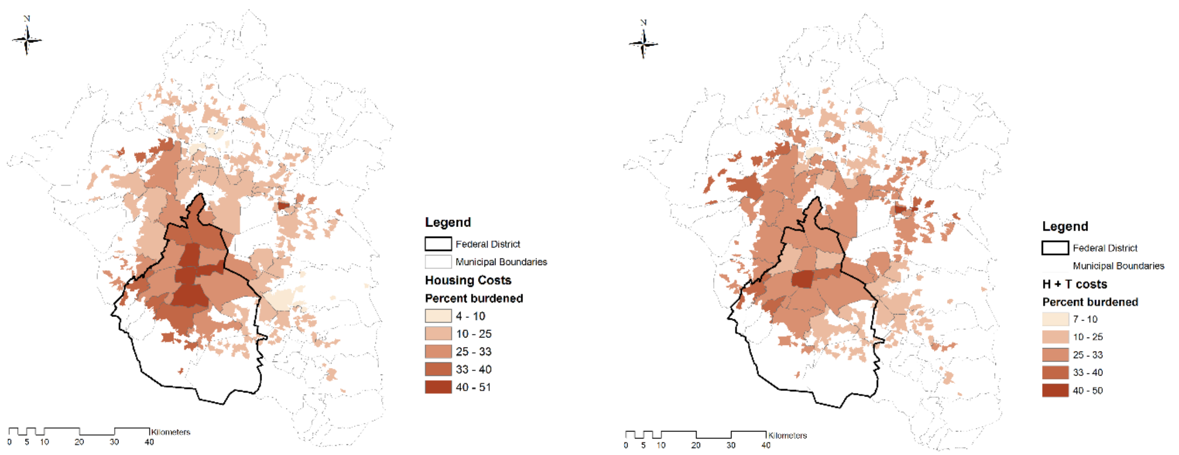


Source: Compiled and calculated by author from Census Tract boundary files from the Instituto Nacional de Estadística y Geografía (INEGI, 2013), OpenStreetMap (2015), and the 2007 household travel survey (INEGI 2007). Default boxplot settings are used with upper and lower arms representing 1.5 times the inter quartile range and outliers excluded.

Measuring affordability in Mexico City

According to data from the 2007 household travel survey, 34% of non-driving households spend more than 30% of their income on rent and qualify as rent-burdened. This number goes about by one percentage point to 35% when accounting for housing and transportation costs. Figure 4.3 maps the percentage of burdened households across municipalities when accounting for rents along and accounting for housing and transportation costs. Across municipalities (boroughs within the dark black outline Mexico City proper), a maximum of half of households are rent-burdened. Accounting for transportation costs changes the geography of affordability, in particular by making the centrally located boroughs more affordable. These areas have the best access to the 200-kilometer metro system, which charges flat fares and is faster and less expensive than road-based forms of transit (Guerra 2014b). Similarly, the far periphery becomes less affordable to its residents when accounting for transit costs. That said many peripheral neighbourhoods have relatively small percentages of H+T-burdened households.

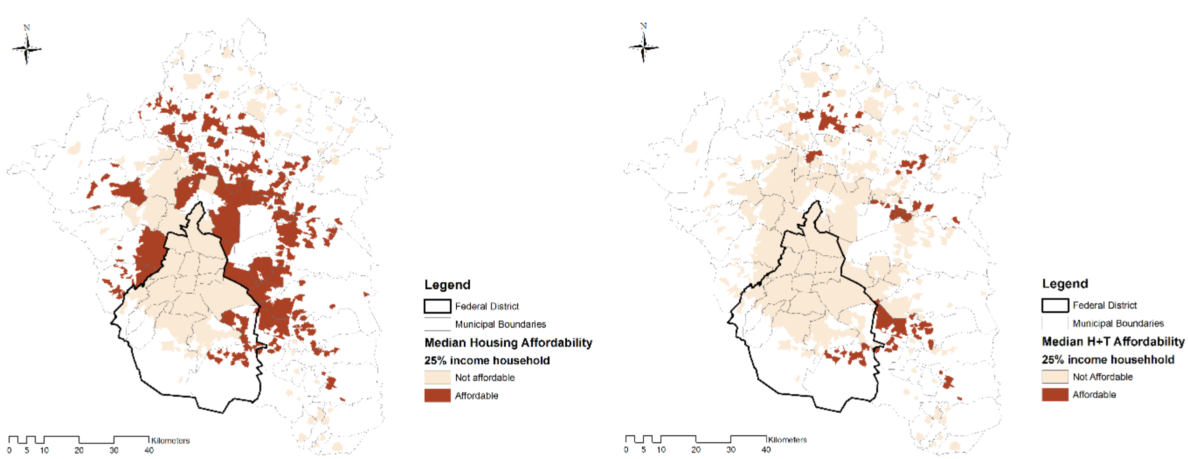
Figure 4.3. **Percent of rent and H+T burdened households by municipality**



Source: Compiled by authors from state, municipal, and locality boundary files from the Instituto Nacional de Estadística y Geografía (INEGI, 2013) and calculations from the 2007 household travel survey (INEGI 2007).

When looking at which municipalities tend to be affordable to a household earning a 25th percentile income, a different spatial pattern emerges (Figure 4.4). The median rent in each central borough is unaffordable to a poor household, while most of the northern and eastern municipalities of the State of Mexico remain affordable. When accounting for transportation costs, however, only a few of the poorer, more remote municipalities remain affordable. Again, there is a pattern that incorporating transportation costs lowers the relative affordability of the periphery and increases the relative affordability of the centre. Nevertheless, median expenditures in most municipalities would burden a household earning the 25th percentile of regional income for non-driving households.

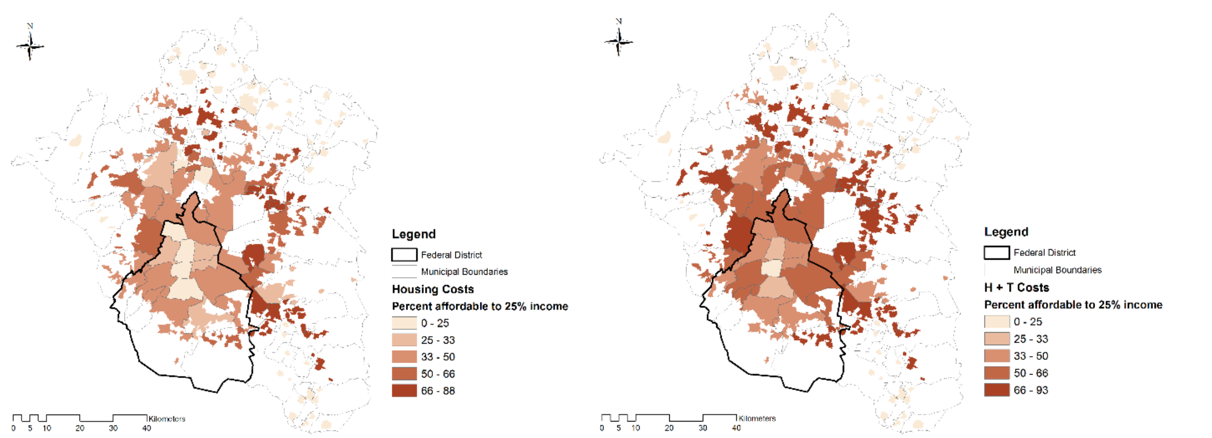
Figure 4.4. **Municipal affordability indices for household earning the 25th percentile income**



Source: Compiled by authors from state, municipal, and locality boundary files from the Instituto Nacional de Estadística y Geografía (INEGI, 2013) and calculations from the 2007 household travel survey (INEGI 2007).

Households, however, probably do not care that much about median prices in an area—one of the fundamental problems of affordability indices and aggregation bias. Instead households care about whether they are able to match to a home that is affordable and meets other needs and priorities, including affordable transportation. Figure 4.5 tries to circumvent this aggregation problem by mapping the percentage of households' housing and transportation expenditures that would be affordable to a 25th percentile income household by municipality. This gives a sense of the relative ease with which a poor household might be able to find suitable accommodations in different parts of the metropolis. Again, adding transportation costs makes central regions relatively more affordable. However, it also tends to increase the affordability of many suburban neighbourhoods. These are the places where many of Mexico City's poor residents live and by necessity or desire are able to reduce transportation and housing expenditures. It is also interesting to note that even some of the wealthier parts of the city sometimes have 25% to 33% of their housing affordable to a poor household when accounting for transportation costs.

Figure 4.5. **Percent of housing options affordable to a household earning the 25th percentile income**



Source: Compiled by authors from state, municipal, and locality boundary files from the Instituto Nacional de Estadística y Geografía (INEGI, 2013) and calculations from the 2007 household travel survey (INEGI 2007).

Policy implications

Taken together, these analyses demonstrate that it is possible to apply an H+T index in a place like Mexico City with relative ease and that the findings are somewhat similar to findings from a US context, at least when excluding car expenses. In general, more transit-friendly central locations appear relatively more affordable when accounting for travel costs as well as housing costs. Since Mexico is the poorest of the OECD countries and the US is one of the wealthiest, these findings likely extend to the rest of the OECD. Unfortunately, a shortage of the necessary data would make it difficult to extend this analysis beyond Mexico City to the rest of the country. Furthermore, the data from the household travel survey are now nearly ten years old. Nevertheless, there are two broad takeaways for public policy in Mexico City and perhaps beyond.

1. Affordable housing policy

First, the principal form of housing production has encouraged substantial new housing development in remote areas with high transportation costs. Over the past two decades, Mexico City's principal form of new housing production has shifted from an informal process, where households built their own properties generally in informal settlements on the periphery, to a formal process where private developers acquire large peripheral lots, build new housing speculatively, and sell completed homes in massive developments to households that qualify for publicly subsidized mortgages (Pardo and Velasco Sánchez 2006, Monkkonen 2011a, 2011b). The public sector is highly involved in this process. Between 1995 and 2005, public agencies funded 75% of all housing loans by value—and even more by volume—in Mexico. Infonavit accounted for 81% of these publicly-financed loans (Monkkonen 2011b).

In addition to remote locations, these commercial housing developments have more parking, wider streets, less-connected street-grids, and less accessible transit stops than nearby informally developed neighbourhoods. These features encourage car ownership and use, which cost even more than transit and reinforce high peripheral transportation costs. Accounting for regional housing location, household income, age, and composition, a household in a commercial development is 62% more likely to own a car and drives nearly four times as much as a household in a traditional neighbourhood (Guerra 2015b).

A consideration of H+T costs instead of just housing costs would encourage a shift in subsidies to favour more central development. This may already be happening in the wake of the Great Recession. Numerous homebuilders have gone bankrupt or failed to report earnings, after foreclosures of tens of thousands of homes, particularly the most peripheral ones (Juarez 2013). President Peña Nieto's administration has made it a public priority reorient government loans to support vertical construction in more central locations (La Crónica de Hoy 2013). However, until home building increases again, it remains to be seen what the effects of the policy will be and whether increases in housing costs can be offset by decreases in transportation costs.

2. Transit investment policy

In 2007, just 11 of Mexico City's 192 metro stations were outside of the Federal District. Nevertheless suburban residents of the states of Mexico and Hidalgo rely on transit for a higher share of trips (65%) than urban residents (60%) and even use the centrally located metro for a similar share (18% vs. 19%) (INEGI 2007). These suburban residents are also poorer and more numerous than centrally located ones. Nevertheless the most notable transit policy of the last decade has been the construction of a new bus rapid transit network, which like the metro is a centralized system that provides only limited service into the populous, dense, and transit-reliant suburbs. Increasing high-capacity transit investments into the suburbs, although expensive, will likely increase housing density around suburban stations and reduce travel times and transportation expenditures for low income households as occurred around the suburban Line B metro extension.

Conclusion and transferability to other OECD nations

Throughout this chapter, we documented the development, technical details, policy uses, and challenges of CNT's H+T affordability index. We then applied a modified version to Mexico City to explore some of the opportunities and challenges of applying the index to another country. Despite some of previously described challenges and critiques of the H+T index, applying an H+T index to OECD countries and cities has the potential to:

- Strengthen the public and policy makers' understanding of which countries, cities, and regions are most affordable;
- Encourage bank lending and the construction of affordable housing in neighbourhoods with higher land costs but lower transportation costs; and
- Focus transit investments in a way that could help to reduce the amount that poorer households spend on transportation.

Transferring the index will likely present two additional challenges:

- **Data availability.** The CNT developed the H+T index specifically to be estimable using publicly available data. Much of this data is not available or comes in a different form in different countries. As a result, no single methodology can or should be applied to all OECD countries and regions. There is insufficient publicly available data to estimate an H+T index in Mexico and applying a model built from the Mexico City region's 2007 household travel survey to census data for other regions would likely create substantial and systematic bias. To estimate an H+T index in Qom, researchers had to conduct their own survey, an expensive and time-consuming endeavour that does not lend itself to the publicly available nature of the H+T index. Estimating the costs of vehicle travel, in particular, is likely to be problematic. Even in the US, it remains unclear how well the model built from Illinois data predicts travel behavior or costs outside of Illinois.

- **Context.** As seen in Mexico City, some preconceived notions about the relationship between transportation costs and housing location do not hold outside of the US. For example, wealthy households in Mexico City generally opt to live in transit accessible areas but own and use cars. This would tend to make central locations look less affordable to poor and moderate-income households than they actually are. Urban economists have found similar differences when comparing American and European cities—a difference that they attribute to the relative desirability of central locations (Brueckner et al. 1999). The US's local control and financing of public school districts almost certainly also leads to substantial differences in housing markets when compared to other countries. Many households move to the suburbs because they cannot afford private schools but view public schools in urban locations as undesirable.

Based on these findings, we stress that no single methodology, model, or dataset can or should be applied throughout OECD countries or regions. If there is interest in extending the index to cover additional OECD nations, we therefore recommend that researchers identify low-hanging fruit, where data are readily available, and test and adopt the index to different contexts. Examples from Mexico City and Qom show that this is possible but that additional data collection and model construction will be necessary and may in fact be specific to each OECD nation.

References

Alonso, W. (1960), "A theory of the urban land market", *Papers in Regional Science, 6 (1)*, 149–157.

Alonso, W. (1964), "Location and land use. Toward a general theory of land rent", Cambridge, MA: Harvard University Press.

Belsky, E., Goodman, J., and Drew, R. (2005), "Measuring the Nation's Rental Housing Affordability Problems".

Bogdon, A. and Can, A. (1997), Indicators of Local Housing Affordability: Comparative and Spatial Approaches. Real Estate Economics, 25 (1), 43–80.

Brueckner, J.K. (1987), "The structure of urban equilibria: A unified treatment of the Muth-Mills model" in: E.S. Mills, ed. *Handbook of Regional and Urban Economics*. New York: Elsevier, 821–845.

Brueckner, J.K., Thisse, J.-F., and Zenou, Y. (1999), "Why is central Paris rich and downtown Detroit poor?: An amenity-based theory", *European Economic Review, 43 (1)*, 91–107.

California Department of Housing and Community Development (2015), Transit Oriented Development (TOD) Housing Program [online]. Available from: http://www.hcd.ca.gov/financial-assistance/transit-oriented-development-housing-program/ (Accessed 28 Feb 2016).

Cervero, R. (2007), "Transit-oriented development's ridership bonus: a product of self-selection and public policies", *Environment and Planning A, 39 (9)*, 2068–2085.

Cervero, R. and Duncan, M. (2002), "Benefits of Proximity to Rail on Housing Markets: Experiences in Santa Clara County", *Journal of Public Transportation, 5 (1)*, 1–18.

Cervero, R. and Kang, C.D. (2009), "Bus Rapid Transit Impacts on Land Uses and Land Values in Seoul, Korea".

Chatman, D. and Voorhoeve, N. (2010), "The transportation-credit mortgage: a post-mortem", *Housing Policy Debate, 20 (3)*, 355–382.

Debrezion, G., Pels, E., and Rietveld, P. (2007), "The Impact of Railway Stations on Residential and Commercial Property Value: A Meta Analysis", *Journal of Real Estate Finance and Economics, 35 (2)*.

Epstein, E., Lynyak, J., Scheffel, D., Vliestra, N., and Ylvisaker, B. (2015), "The U.S. Supreme Court's Decision in Texas Department of Housing & Community Affairs v. Inclusive Communities Project, Inc", Available at: https://www.dorsey.com/newsresources/publications/client-alerts/2015/06/the-us-supreme-courts-decision-in-itexas-departm__.

Ewing, R. and Cervero, R. (2010), "Travel and the built environment: a meta-analysis", *Journal of the American Planning Association, 76 (3)*, 265–294.

Feins, J.D. and Lane, T.S. (1981), "How much for housing?: new perspectives on affordability and risk", Cambridge, Mass: Abt Books.

Glaeser, E.L., Kahn, M.E., and Rappaport, J. (2008), "Why do the poor live in cities The role of public transportation", *Journal of Urban Economics, 63 (1)*, 1–24.

Governors' Institute, n.d. "Policies that Work: A Governors' Guide to Growth and Development".

Guerra, E. (2014a), "The Built Environment and Car Use in Mexico City Is the Relationship Changing over Time?", *Journal of Planning Education and Research, 34 (4)*, 394–408.

Guerra, E. (2014b), "Mexico City's suburban land use and transit connection: The effects of the Line B Metro expansion", *Transport Policy, 32,* 105–114.

Guerra, E. (2015a), "The geography of car ownership in Mexico City: a joint model of households' residential location and car ownership decisions", *Journal of Transport Geography, 43*, 171–180.

Guerra, E. (2015b), "Has Mexico City's shift to commercially produced housing increased car ownership and car use?" *Journal of Transport and Land Use, 8 (2)*, 171–189.

Hess, D.B. and Almeida, T.M. (2007), "Impact of Proximity to Light Rail Rapid Transit on Station-area Property Values in Buffalo, New York", *Urban Studies, 44 (5-6)*, 1041 –1068.

Holtzclaw, J., Clear, R., Dittmar, H., Goldstein, D., and Haas, P. (2002), "Location Efficiency: Neighborhood and Socio-Economic Characteristics Determine Auto Ownership and Use - Studies in Chicago, Los Angeles and San Francisco", *Transportation Planning & Technology, 25 (1),* 1–27.

INEGI (2007), "Encuesta Origen - Destino de los Viajes de los Residentes de la Zona Metropolitana del Valle de México 2007", Mexico City: Instituto Nacional de Estadística, Geografía e Informática.

INEGI (2016) , "Encuesta Nacional de Ingresos y Gastos de los Hogares (ENIGH)", INEGI. http://www.inegi.org.mx/est/contenidos/Proyectos/Encuestas/Hogares/regulares/Enigh/default.aspx (Accessed 25 Feb 2016).

Isalou, A., Litman, T., and Shahmoradi, B. (2014), "Testing the housing and transportation affordability index in a devloping world context: A sustainability comparison of central and suburban districts in Qom, Iran", Transport Policy, 33, 33–39.

Jewkes, M. and Delgadillo, L. (2010), "Weaknesses of Housing Affordability Indices Used by Practitioners", *Journal of Financial Counseling and Planning, 21 (1).*

Juarez, E. (2013), "Sedatu busca atacar abandono de vivienda", *El Economista*, 21 Jul.

Kahn, M. (2007), "Gentrification Trends in New Transit-oriented Communties: Evidence from 14 Cities that Expanded and Built Rail Transit Systems", *Real Estate Economics, 35 (2),* 155–182.

Knapp, G.-J. (2001), "Do Plans Matter?: The Effects of Light Rail Plans on Land Values in Station Areas", *Journal of Planning Education and Research, 21 (1),* 32–39.

La Crónica de Hoy (2013), Ordena Peña Nieto revisar requisitos para otorgar créditos de vivienda. *La Crónica de Hoy*, 11 Apr.

Mills, E.S. (1972), "Studies in the Structure of the Urban Economy. Baltimore", The Johns Hopkins Press.

Monkkonen, P. (2011a), "The Housing Transition in Mexico Expanding Access to Housing Finance", *Urban Affairs Review, 47 (5)*, 672–695.

Monkkonen, P. (2011b), "Housing Finance Reform and Increasing Socioeconomic Segregation in Mexico", *International Journal of Urban and Regional Research, 36 (4)*, 757–772.

Muth, R.F. (1969), "Cities and Housing; The Spatial Pattern of Urban Residential Land Use. Chicago", University of Chicago Press.

OpenStreetMap Wiki contributors (2015), OpenStreetMap Wiki, Main Page. Available from: http://wiki.openstreetmap.org/wiki/Main_Page (Accessed 16 Sep 2015).

Pardo, M. del C. and Velasco Sánchez, E. (2006), "El proceso de modernización en el Infonavit 2001-2006: estrategia, redes y liderazgo", México, D.F.: Colegio de México.

Pelletiere, D. (2008), "Getting to the Heart of Housing's Fundamental Question: How Much Can a Family Afford: A primer on Housing Affordability Standards in U.S. Housing Policy".

Renne, J. (2008), "Smart Growth and Transit-Oriented Development at the State Level: Lessons from California, New Jersey, and Western Australia", *Journal of Public Transportation, 11 (3)*.

Rodríguez, D.A. and Targa, F. (2004), "Value of accessibility to Bogotá's bus rapid transit system", *Transport Reviews: A Transnational Transdisciplinary Journal, 24 (5),* 587–610.

Smart Growth America (2016), "Housing Policy Guide", Available from: http://www.smartgrowthamerica.org/guides/smart-growth-at-the-state-and-local-level/housing-policy/ (Accessed 3 Mar 2016).

Tegeler, P. and Chouest, H. (2010), "The 'Housing + Transportation Index' and Fair Housing", *Poverty & Race, 19 (4)*, 13–14.

Texas Department of Housing and Community Affairs (2010), "What Research Shows: What Other States are doing to Link Housing and Transportation", White Paper.

US Department of Housing and Urban Development (2016), Location Affordability Portal. http://portal.hud.gov/hudportal/HUD?src=/program_offices/economic_resilience/location_affordability (Accessed 3 Mar 2016).

US Department of Housing and Urban Development (2016), FY 2015 Income Limits, Available from: https://www.huduser.gov/portal/datasets/il/il15/index.html (Accessed 3 Mar 2016).

Chapter 5
Perspectives for integrating housing location considerations and transport planning as a means to face social exclusion in Indian cities

Geetam Tiwari
Transportation Research and Injury Prevention Programme,
Indian Institute of Technology Delhi, India

This chapter highlights the urban development in India and implications for low income households living in informal settlements or slums. The chapter is divided into four sections. The first one describes urban development pattern in India. A second section presents a summary of policies since 1950 which have been implemented to address the housing needs of low income households in cities. The chapter then presents impacts of various housing and resettlement policies in selected cities in India. A final section summarizes key insights from self-planned low income settlements in cities-the slums-, and expert planned low income settlements as part of resettlement policies.

Urban development pattern in India

21st century has been termed as the urban century since majority of the world population is living in urban area since 2010. UN report (2014) notes the following three important issues regarding urbanisation:

- Over 90% of urban growth is occurring in the developing world and an estimated 70 million new residents are added to urban areas of developing countries each year. Over the next two decades, the urban population of the world's two poorest regions — South Asia and Sub-Saharan Africa — is expected to double, suggesting that the absolute numbers of informal settlement and slum dwellers in these regions will dramatically grow.
- Informal settlements, slums and other poor residential neighbourhoods are a global urban phenomenon. They exist in urban contexts all over the world, in various forms and typologies, dimensions, locations and by a range of names (squatter settlements, favelas, poblaciones, shacks, barrios bajos, bidonvilles). While urban informality is more present in cities of the global south, housing informality and substandard living conditions can also be found in developed countries.
- Slums affect the prosperity of cities and their sustainability. While on the one hand these areas are acknowledged as providing much-needed mixed land use to cities and as having an active informal economy that, in many countries, provides the majority of jobs, on the other hand, these informal jobs are unskilled, very-low-paid, and insecure livelihood options, part of a 'subsistence economy' that allows inhabitants to survive but not to progress sufficiently to change their living conditions nor to realize the full potential contribution to urban productivity.

In the background of these three important characteristic of current urbanization we explore the urban development and urbanization in India, formal and informal response to deal with these issues and impact of formal policies on the lives of urban poor.

Urbanization and economic growth

India's current population is 1.21 billion. The population is expected to grow at the rate of 1.8-1.5% per annum by 2030. Therefore, the estimated population of India by 2040 will be in the range of 1.5-1.7 billion. The Indian economy has been growing at a rate of more than 7% for the last four years. However, the urbanization process has been slow in India. The analysis of development dynamics in the 1990s shows that there has been an all-round decline in the growth of employment. Income growth and incidence of poverty have been extremely uneven across states. Thus a slowing down in the rate of urbanization and concentrations of demographic growth in developed states seem to be the logical outcome. The process of urbanization has also become exclusionary in nature, as only a few large cities with a strong economic base are able to raise resources for development, leaving out small and medium towns (Kundu 2006). India is 30% urbanized and is expected to reach 40% by 2040. The current per capita income of USD 1 061 is expected to increase to USD 12 000 in the high growth (9% per annum) scenario and USD 6 000 in the low growth rate (6-7% per annum) scenario.

As per Census 2011, there are 468 cities having population more than 0.1 million. These urban agglomerations and cities are grouped into four categories as small, medium, large and mega cities (Table 5.1).

Table 5.1. **Provisional population 2011 by Census of India**

Category	Groups	Population (million)	Total no. of	Percentage	Total
1	Small	0.1 – 0.5	372	28%	73 930 414
2	Medium	0.5 – 1.0	43	11%	30 235 593
3		1.0 – 2.0	34	18%	46 686 245
4	Large	2.0 – 4.0	10	9%	24 265 267
5		4.0 – 8.0	4	9%	23 736 923
6	Mega	> 8.0	5	25%	66 037 071
Total			468		264 891 513

Source: Census, 2011

Nearly 60% of urban population lives in cities which have 2 million population or less. Five megacities which have more than 8 million population have twenty five percent of total urban population. Substantial proportion of this population lives in slums. The recent growth of the urban population has aggravated the crunch of urban land, which, coupled with scarcity of affordable housing, has led to proliferation of informal settlements housing the poor that have become a part of the cityscape of Indian cities (Ahluwalia, 2011).

Economic growth

At a likely GDP growth rate of 7.5 to 8 percent per year, real per capita GDP is expected to reach USD 2 700 by 2030, a five-fold increase over the 2005 level. India's population is likely to reach 1.5 billion. This growth will be accompanied by increased urbanization, with well over 550 million (40%) of India's people living in cities two decades from now. This shift towards a more urban economy will expand demand for services like housing, power and transport. The vehicle fleet is expected to increase from a little over 50 million today to about 380 million by 2030 (McKinsey & Company 2009).

India's GDP (nominal) is forecast to increase from USD 1 256 billion in 2010 to USD 6 683 billion in 2030, USD 16 510 billion in 2040 and USD 37 668 billion in 2050. Per capita GDP trend has been forecast in terms of GDP- nominal and per capita in Table 5.2.

Table 5.2. **Forecast of GDP trends**

	2010	**2020**	**2030**	**2040**	**2050**
GDP (nominal) USD billion	1 256	2 848	6 683	16 510	37 668
GDP (per capita)	1 061	2 091	4 360	9 802	20 836

Source: (Wilson and Stupnytska 2007)

It is clear that after twenty five years from now per capita GDP in India will remain low (<USD 1 0000), therefore presence of poor households and informal settlements in urban area will remain a challenge for urban planners.

Informal sector and urbanisation

A large proportion of urban residents in India live in self-planned informal settlements in cities. Informality has been defined in many ways. It is outside what is official or legal or planned. It is certainly not a synonym for criminality which is both outside the law and illegal. Squatter settlements all over the world are called informal settlements because they are not part of the official plan. Nuewirth

(2005) describes the squatter as a new migrant to the city who builds a shelter with his own hands on the land that does not belong to him. Nearly one billion people who live in squatter settlements are people who came to the city in search of jobs, needed a place to live that they could afford, and not being able to find it on the private market, built it for themselves on land that wasn't their own. These informal settlements create a huge hidden economy- an unofficial system of squatter landlords and squatter tenants, squatter merchants and squatter consumers, squatter builders and squatter labourers, squatter investors and squatter brokers. The builders of informal housing are the largest builders of housing in the world- and they are creating the cities of tomorrow. The conventional definition of informal-unofficial, illegal or unplanned denies people jobs in their home areas and denies them homes in the areas where they have gone to get jobs.

A significant proportion of urban population in Indian cities remains outside the formal planning process. People living in informal settlements dependent on informal economy for survival in the city are an integral part of Indian cities. Table 5.3 shows share of slum population in selected cities in India. Generally as the city size increases, share of population living in slums also increases.

Self-planned (informal) settlements in Indian cities

Often in Indian cities squatter settlements develop inside the city close to commercial centres, planned housing developments, and factories. Soon these settlements demand varied services needed by the residents- low cost food, vegetables, tailors, etc. It is a common sight in Indian cities to have street vendors along the roads selling food, toys, flowers and various handicrafts made by family members. Thus the informal sector provides employment opportunity to each and every family member and rewards for their creative endeavours. Growth of formal sector is accompanied with the growth of informal sector, with the latter showing higher growth rates than the formal sector. This is not surprising as the informal sector grows to serve the formal sector as well as to serve the informal sector.

Informal sector develops firstly because of rural-urban migration which is based on a comparison of rural and urban opportunities. Formal sector in urban area requires unskilled or low level of skills provided by the migrant labour. Construction labour, casual labour in factories and commercial establishments depend on migrant labour. Higher income families require domestic help, gardener, carpenter, plumber, electrician etc. for normal functioning.

The patterns of development in Indian mega cities are an amalgam of planned and organic (self-organising) growth. Survival compulsions force poor population to evolve as self-organising systems. These systems rest on the innovative skills of people struggling to survive in a hostile environment and meet their mobility and accessibility needs. Housing, employment and transport strategies adopted by this section of the society are often termed as "informal housing, informal employment and informal transport". Transport solutions evolved by this section of the society do not become part of the official policies. Their existence is mostly viewed as creating problems for the "normal traffic". Formal plans have no place for informal transport. Therefore, most cities face a complex situation where the investments are for formal plans, whereas needs of a significant section of the society is met by informal transport. Is this desirable or sustainable?

Table 5.3. **Percentage of slum population in selected cities in India**

Million plus cities	Percentage of slum households of total urban households (%)
Greater Mumbai	41.3
Kolkata	29.6
Chennai	28.5
Delhi	14.6
Bengaluru	8.5

Source: Census of India, GoI (2011)

Out of 13.7 million households living in slums in India, as per census 2011, 5.2 million households live in 46 million-plus cities, or, 38% of the total slum population is situated in these million-plus cities. The five metro cities, which attract large number of migrant population have a high share of slum population as shown in Table 5.3.

Slum free cities

Formation of slums in cities was recognized as a serious concern in India since 1950s. Slum eradication Act 1956 was adopted by the Indian parliament in 1956. The national housing policy of India identified shelter as a basic human need, in 1956. However, there had been no comprehensive plan for housing until 1988 in the country (The first National Housing Scheme was introduced in 1988).

In the First Five Years Plan, with schemes like Housing Scheme for Industrial Workers (1952), Housing for Low Income Group (1954) and Housing Scheme for Plantation Workers (1952) the focus was to provide housing for the LIGs (low-income group). The Second Five Year Plan recognised the needs of slums, their improvement and resettlement. Until the fifth plan period from 1974 to 1979, the emphasis was only on certain weaker sections of the society. From the Sixth plan period onwards, the community development programmes were promoted with active role of the non-profit organizations. After liberalisation of Indian Economy in the nineties, (i.e., from the Eighth plan onwards) the market forces gained more importance and the role of the State was transformed from a provider to that of an enabler (Mukhija, 2004). The National Housing Policy of 1988 was more inclined towards the housing provisions for the higher and the middle-income section. In 1994 this Housing policy was revised with the aim to provide affordable housing for all in the country and strengthen the enabling strategies (Sivam & Karuppannan, 2002). Both public and private sector provide housing in India contributing 16 and 84% respectively. The private sector is active in both the formal and informal categories of housing. The formal housing stocks are unaffordable for the economically weaker section and hence they are provided with the informal housing stocks in the form of slums. The inability of the Government to see housing as a major economic sector has resulted in the absence of any financial structure until 1970. The Housing and Urban Development Corporation (HUDCO) was created in 1970 for providing financial assistance to the LIGs for augmenting the housing stock. Other important contributors to housing finance are Housing Development and Financial Corporation and Life Insurance Company. In 1988 the National Housing Bank was set up as a subsidiary of the Reserve Bank of India to finance housing schemes (Sivam and Karuppannan, 2002).

Bardhan et al. (2015) have analysed four groups of policies to explain the impact on low income households in Mumbai: i) land and housing, (ii) related to clearance and eviction, (iii) upgradation and redevelopment, and (iv) recent initiatives. The first group consists of the two major policies implemented by the Central government – the Rent Control Act (1947) and the Urban Land Ceiling Act (1976). The second group consists of the Slum Improvement and Clearance Act (1956), The Slum Areas (Improvement, Clearance and Redevelopment) Act (1971) and the Maharashtra Vacant Land (Prohibition of Unauthorized Structure and Summary Eviction) Act (1975), all primarily motivated towards the removal of slums from urban areas. The third group has the policies, which were intended to the development of slum areas, and these are the Slum Upgradation Programme (1985), the Prime Minister's Grant Project (1985), Slum Redevelopment Scheme (1991) and the Slum Rehabilitation Scheme (1995). Finally, the last group has the schemes like the Rajiv Awas Yojna (2013) and Cluster Redevelopment Projects (2014), which are the recent initiatives in housing policies.

The Slum Area Improvement and Clearance Act of 1956 (Government of Maharashtra, 1956) identified the slum areas as places where the buildings are in any respect unfit for human habitation; or are by reasons of dilapidation, overcrowding, faulty arrangement and design of such buildings, narrowness or faulty arrangement of streets, lack of ventilation, light or sanitation facilities, or any combination of these factors, are detrimental to safety, health or morals.

There were provisions for possible improvement and demolition of the buildings as well as that of clearance and redevelopment of the slum areas. The act did not mention about the resettlement plans of the evicted households. This was a major gap in the planning process as without any resettlement plan the easiest option open to the evicted households was to settle in other slum areas or create new slums. Hence, on one hand the Act ensured clearance of urban land; on the other hand it triggered the slum growth further.

The Slum Areas (Improvement, Clearance and Redevelopment) Act, 1971 according to this Act, "No person shall, on or after the appointment date, occupy any vacant land or continue to in occupation of any vacant land in urban area or erect any shelter or enclose or other structure on such land for the purpose of residence or otherwise without the express permission in writing of the Municipal Commissioner in a corporation area, of the Chief in a Municipal area and elsewhere, of the Collector, or except in accordance with any law for the time being in force in such urban area"(Government of Maharashtra, 1975). The Act also states that in cases of contravention the Competent Authority "….may by order requires such person to vacate the land ….and to remove all property there from and if such person fails to comply with the order …, he may be summarily evicted from such land …." (Government of Maharashtra, 1975). This Act led to wide scale eviction of slums and squatters, which were identified as being encroachments. The Act does not mention anything about the relocation of the evicted households and hence like the abovementioned Acts, we find a major gap in the planning process too.

Any large-scale clearance and eviction process makes a large section of low income people houseless. These households often take shelter in the other slums or they become pavement dwellers. These processes seriously damage their livelihood as their occupations are largely driven by the selection of their housing location. Either they are located near to their workplaces or the slums themselves get established as an economic centre. In case of eviction, both the occupational structures get heavily affected. In Mumbai on an average a slum dweller family spends INR 30 000 to 50 000 in constructing their house, due to demolition (Das, 2003). Bardhan et al. (2015) have discussed the verdict given by the Supreme Court of Indian against the eviction of illegal settlements in the Olga Tellis vs. Bombay Municipal Corporation court case in 1985,where the Supreme court identified the relation between habitation and livelihood (Ramanathan, 2005). This can be regarded as the initiation of the in situ slum improvement schemes.

Policies related to upgradation and redevelopment:

The Slum Upgradation Programme (SUP) was introduced in 1985 as part of the Bombay Urban Development Project, in collaboration with the World Bank. It was joined by another similar programme called the Low Income Group Shelter Programme. The basic motive of SUP was to provide renewable lease of land to the slum cooperative societies for a period of 30 years. It would provide loans to the slum dwellers at an interest rate of around 12% and also ensure provision of basic amenities on a cost recovery basis. The slums on the private lands and the central government lands were out of the jurisdiction of this programme. Hence the impact of the programme was not as widespread as expected. The State also issued identity passes to the head of the household to prove their eligibility in receiving the leasehold tenure. The impact of the programme was

In 1985 a Central grant of INR one billion was announced of which INR 600 million was used for the upgradation and improvement of Dharavi (Barke, O' Hare, & Abbott, 1998). The funds were used to provide housing for the slum dwellers and also to improve conditions of the existing infrastructure. It recommended 30 000 to 35 000 families to be accommodated within Dharavi and 20 000 families to be relocated outside Dharavi (Mukhija, 2001). Transit camps were set up to temporarily relocate the households during the construction process. There were problems like shortage of transit settlements, delays in construction, lack of awareness among the beneficiaries, higher prices of the newly created housing stocks and manipulation of the beneficiary list by the outsiders. As such the housing stocks remained limited and the idea of affordable housing was not successful.

The liberalisation of the Indian market in 1991 invited large scale foreign investment into the housing sector as well. The ruling party introduced a new scheme called the Slum Redevelopment project, inviting the private investors to take up the job of slum redevelopment. As an incentive the FSI of the slum areas were increased up to 2.5 from 1.33, which encouraged the construction of high rise buildings. As per the scheme the private developers should carry out in situ redevelopment of the notified slum area by rehousing the slum dwellers into tenements measuring 180 sq. feet (16.72 m²) and the rest of the place was available for them to build and sell in open market. This is how the builders were compensated of their cost of construction and resettlement. However, the houses for the slum dwellers were not free, and they had to pay a certain part of the construction cost. Also there was an added criterion of eligibility, where the slum dweller had to establish his duration of stay in the existing from before that of 1985. This cut-off date made a large section of the slum population ineligible for getting rehousing facility and there was no alternative measures recommended for the ineligible section. Also the scheme failed to attract the interest of the private developers and all in all, the scheme was criticized for inefficiency (Risbud, 2003). The success of the scheme depended on high property rates, to benefit large developers and builders who thus became instrumental in evacuating slums from prime lands of the city (Banerjee Guha, 2002).

A modified version of the Slum Redevelopment Scheme (SRS) was brought up by the newly elected party in 1995. Following the recommendations of the Afzalpurkar Committee (1995), a separate body called Slum Rehabilitation Authority was set up to exclusively look into the matters related to slum resettlement. Thereby three types of rehabilitations were recommended, viz. In Situ, Project Affected People (PAP) and Permanent Transit Tenement (PTT). The year of eligibility criterion was raised to 1995 and recently to 2000, and the scheme also includes the pavement dwellers. The size of the tenements has been increased to 225 sq. feet (20.9 m²) to recently to 269 sq. feet (24.99 m²). The tenements were made totally free for the slum dwellers. The private developers were provided incentives in the form of free sale component of 7.5 sq. feet for every 10 sq. feet free rehabilitation construction. The sale ratio varied from 1:0.75 in the inner city to 1:1 in the suburban areas. Since the FSI of the resettlement areas was fixed at 2.5, the additional area was made available in the form of generating Transferable Development Rights.

The Slum rehabilitation Scheme is hence driven by the interest of the private developer and the strength of the real estate forces. The scheme of rehabilitation is more inclined towards the interests of the wealthy developers rather than the actual slum population. According to Patel (1996), it is mixture of "admirable and dubious". The strong market forces favour active rehabilitation and vice versa. The impact also varies with the variation in the local property prices. The developers will be more interested in areas where the sale component can fetch higher prices. Though the SRS scheme seems to be very lucrative, the true statistics fail to establish it as a real success (Das, 2003 and Nijman, 2008). In April 2014, the total number of completed units was 157 402 and 86 069 units are under construction (Praja, 2014).

Similar policies have been followed in Delhi and Chennai and other major cities.

Bhan and Shivanand (2013) have analysed displacements in Delhi from 1990-2007. It was noted in 2000, 14.8% of the population of Delhi lived in Jhuggi Jhompri (JJ) clusters, and 12.7% lived in resettlement colonies where they had been placed post-eviction with some measure of security of tenure (Government of Delhi 2006). It is thus within negotiating and delaying, if not preventing, eviction and subsequently fighting to access resettlement that the poor have historically claimed shelter in the city. It is a process of settlement that is never complete, one in which the poor are constantly (un)settled, regardless of how many decades they may have lived in the city, and one that, in turn, constantly produces and maintains the contemporary Indian city itself as unsettled. Analyses by Bhan and Shivanand (2013) and Dupont (2008), among others, suggest at least 218 evictions between 1990 and 2007 in the capital, covering at least 60 000 households. Recent documentation of heightened evictions for the Commonwealth Games in 2010 indicates the continuation and deepening of this trend post-2007 (HLRN 2010). This documentation of widespread evictions is now affirmed by the Census 2011, which states in that "a major reason for the fall in the decadal growth rate (in Delhi) is the wide-ranging removal of slum JJ clusters from various parts of the city". Preliminary data further suggest "a significant fall in the slum population despite broadening the definition of slums for the 2011 Census". Particular districts bear the brunt of these evictions – "It has been established that removal of slum clusters within the NDMC (New Delhi Municipal Council) Area is the primary reason for a 25% fall in population in the New Delhi district vis-à-vis 2001" (Government of India 2012: 44). The districts of New Delhi and Central Delhi recorded negative decadal growth rates while North West Delhi recorded the second highest decadal growth rate, primarily attributed to the building of resettlement colonies such as Bawana, Bhalsawa, and Savda-Ghevra.

It is clear from the above discussion that slum problem has been understood largely as lack of affordable housing. While decent housing continues to remain unaffordable to a large proportion of slum dwellers in most Indian cities, evictions continue and resettlement strategies have had major adverse effect on livelihoods of millions of households in Indian cities.

The new central government came to power in 2014 and proposed a major shift from the earlier policies and announced "The smart city initiatives". Ministry of Urban Development, Government of India Website states: The purpose of the Smart Cities Mission is to drive economic growth and improve the quality of life of people by enabling local area development and harnessing technology, especially technology that leads to Smart outcomes. Area based development will transform existing areas (retrofit and redevelop), including slums, into better planned ones, thereby improving liveability of the whole City. New areas (greenfield) will be developed around cities in order to accommodate the expanding population in urban areas. Application of Smart Solutions will enable cities to use technology, information and data to improve infrastructure and services. Comprehensive development in this way will improve quality of life, create employment and enhance incomes for all, especially the poor and the disadvantaged, leading to inclusive cities. There is no specific mention of policies required to address the problems of slums or informal settlements.

The first twenty cities have been selected to receive funding from the central government in February 2016. The emphasis is on application of IT and smart solutions. There is no mention of the existence of informal settlements.

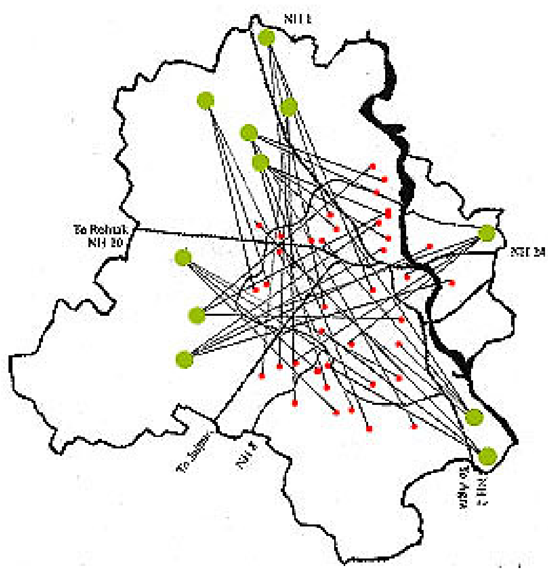
Impact of eviction and resettlement policies

This section presents impact of eviction and resettlement policies on low income household in Delhi, and Chennai. Similar impacts are expected in other Indian cities.

Urban planning policies and relocation of poor households in Delhi

Delhi has witnessed large-scale evictions and resettlement since 1998. Before this large scale evictions were carried out in 1977 during the imposition of emergency rule in India. Large numbers of low-income households have been relocated for development projects like commercial complexes, flyovers, recreational parks, and wide roads to improve the landscape of the city. Figure 5.1 shows the trends of eviction of low-income settlements from the central areas of the city and relocation to the peripheral areas. Peripheral development and relocation of urban squatters has meant an increase of the spatial segregation of social groups. This has also resulted in poor access to income-generating activities.

Figure 5.1. **Location of low income settlements (green dots: original location, red dots: relocation by experts)**



Source: Hazard Centre, 2001

Table 5.4 shows number of households who have been shifted to resettlement colonies. More than 40 000 households have been shifted from the central city location to the periphery of the city. This has resulted in an increase in travel distance to work as well as to the public transport stop.

Table 5.4. **Number of households moved between 1997-2003**

Site number	No. of households	Distance from original site
1	8 000	8 km
2	4 000	7 km
3	5 000	18 km
4	3 000	10 km
5	2 300	12 km
6	50	5 km
7	500	18 km
8	5 500	23 km
9	4 500	20 km
10	1 000	15 km
11	4 000	18 km
12	50	8 km
13	65	35 km
14	20	40 km
15	1 200	25 km

Source: Anand, 2007

Arora and Tiwari (2007) studied 2 000 households in Delhi to estimate the impact of relocation due to metro construction in Delhi. The study documented accessibility and mobility conditions of households residing in the city in slums before the construction of metro, and after they were relocated to new locations planned by the city authorities at the outskirts.

Accessibility

Accessibility is a description of the proximity to destinations of choice and the facilitation offered by the public transport systems to reach them (Anand, 2007).

The indicators of accessibility are defined as:

- The Public Transport Accessibility (APT) measures distance cost and time to bus stop and metro stops.
- The Spatio-Travel Accessibility (AST) has two components and is derived from household surveys (both in self-planned settlements in the vicinity of the metro line, and households relocated to expert planned settlements):
  - Spatial Accessibility (AS) describes the land-use components of accessibility.
  - Travel Accessibility (AT) describes the accessibility of land use and transport systems for the households surveyed.

Mobility

Mobility is both the ability to travel to destinations of choice and the amount of movement necessary to do so. By definition, the household's ability to travel is seen as positive mobility from the socio-economic perspective because it indicates that people are traveling for employment, education and other purposes, thus enabling value addition to the households. On the other hand, the amount of movement is seen as negative mobility from the socio-economic perspective because it uses resources of the household, like time and money, which could have been better utilized to upgrade the quality of life of the household.

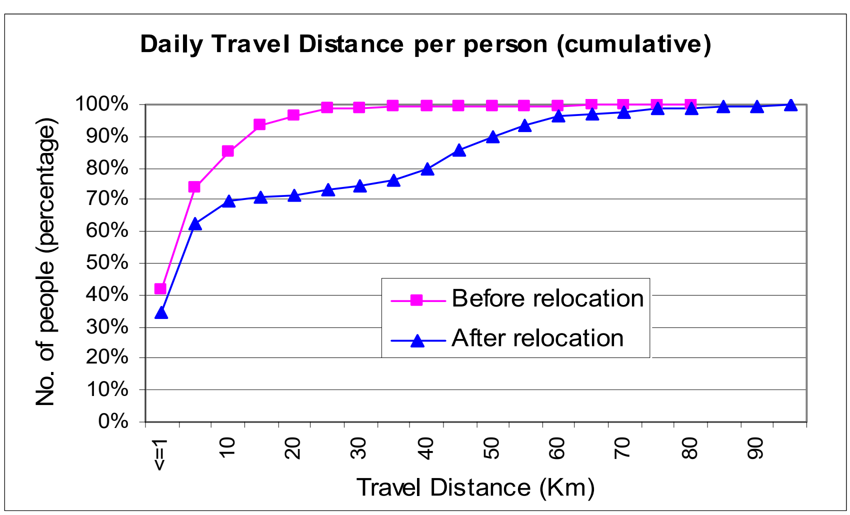
Table 5.5. **Percentage change in AST indicators for households relocated**

Change category	$D_{education}$ (diff)	D_{health} (diff)	$D_{services}$ (diff)	$D_{busstop}$ (diff)	S_{bus} (diff)
Total decrease	40.8%	33.8%	36.3%	13.9%	1.5%
No change	7.5%	3.5%	11.9%	14.4%	0.0%
Total Increase	51.7%	62.7%	51.7%	71.6%	98.5%

Source: Anand, 2007

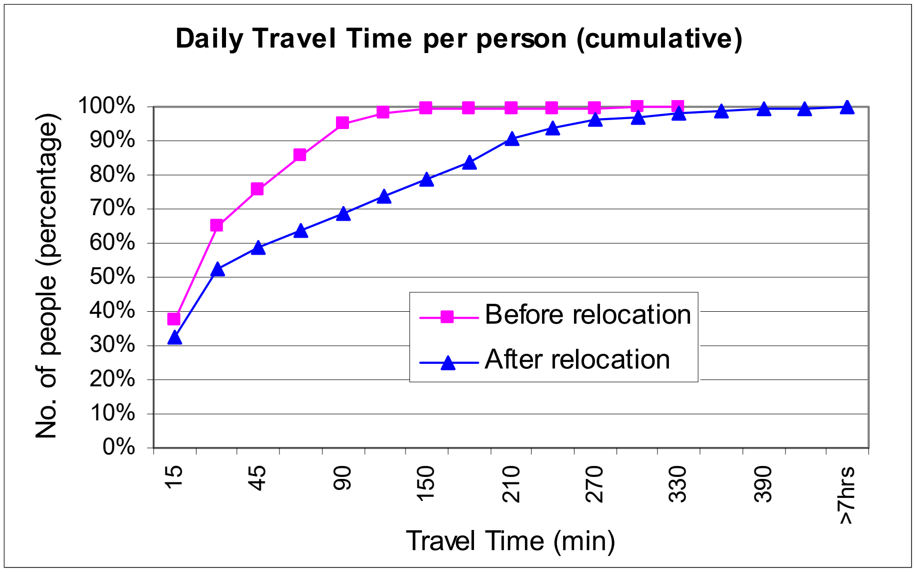
Table 5.5 shows that, for the relocated households, the value of all the indicators have changed. The distance to schools ($D_{education}$) has increased for 52% of the households but decreased for 41% of the households. Similarly, the distance to health services (D_{health}) has increased for 63% of the households and decreased for 34% of the households. Also, the distance to urban services ($D_{services}$) has increased for 52% of the households and decreased for 36% of the households. The highest impact is seen in the indicators measuring access to bus system – the distance to the bus stop ($D_{busstops}$) has increased for 72% of the households and the time gap between successive buses (S_{bus}) has increased by more than 100% for 98% of the households. Figure 5.2 and 5.3 show change in distance and travel time before and after relocation.

Figure 5.2. **Change in travel distance before and after relocation**



Source: Anand, 2007

Figure 5.3. **Change in travel time before and after relocation**



Source: Anand, 2007

Table 5.6 shows that, for the households living in settlements which have not been relocated, there is some change in the indicators of per capita trip rate (PCTR) for work (there is no change for 78% of the households and it increases for 13% of the households) and other purposes (there is no change for 82% of the households and it decreases for 14%), but little change in the PCTR for education (there is no change for 91% of the household. The share of NMVs in the modes used for travel in households does not change for 87% of the households, increases for 7% and decreases for 5% of the households.

Table 5.6. **Percentage change in mobility indicators for households in the vicinity of the metro line**

Change category	**$PCTR_{work}$ (diff)**	**$PCTR_{edu}$(diff)**	**$PCTR_{others}$(diff)**	**M_{nmv}/M_{all}(diff)**
Total decrease	9.4%	3.9%	13.8%	5.4%
No change	77.8%	91.1%	81.8%	87.2%
Total increase	12.8%	4.9%	4.4%	7.4%

Source: Anand, 2007

Table 5.7 shows minimum change in the mobility indicators regarding travel for education (distance, time, cost). The distance to work, the time to work and the cost has not changed for 73%, 72% and 91% of households respectively and has increased for 17%, 17% and 5% of households respectively. For trips made for other purposes, the distance, time and cost indicators have not changed for 72%, 72% and 93% households respectively, and have decreased for 15%, 16% and 4% households respectively.

Table 5.7. **Percentage change in MP indicators for households in the vicinity of the metro line**

Change category	D_{work} (diff)	$D_{education}$ (diff)	D_{others} (diff)	T_{work} (diff)	$T_{education}$ (diff)	T_{others} (diff)	C_{work} (diff)	$C_{education}$ (diff)	C_{others} (diff)
Total decrease	10.3%	3.9%	15.3%	13.8%	4.4%	16.3%	3.4%	0.0%	4.4%
No change	72.91%	90.64%	72.41%	69.46%	88.67%	71.92%	91.13%	100.0%	93.60%
Total increase	16.7%	5.4%	12.3%	16.7%	6.9%	11.8%	5.4%	0.0%	2.0%

Source: Anand, 2007

Tables 5.8 and 5.9 show that, for the households relocated as per the land use policy, the value of all the mobility indicators have changed for the majority of the households. Table 5.8 indicates that for 49% households, the PCTR for work has increased and for 30% of the households it has decreased. For 71% of households, the PCTR for education does not change – it increases for 19% and decreases for 10% of the households. The PCTR for other purpose has increased for 35% of the households and decreased for the same percent of households. The share of NMVs in the mode used has decreased for 59% of the households.

Table 5.8. **Percentage change in MHH indicators for households relocated to expert planned settlements**

Change category	$PCTR_{work}$ (diff)	$PCTR_{edu}$(diff)	$PCTR_{others}$(diff)	M_{nmv}/M_{all}(diff)
Total decrease	29.9%	10.4%	35.3%	58.7%
No change	21.39%	70.65%	29.35%	21.89%
Total increase	48.8%	18.9%	35.3%	19.4%

Source: Anand, 2007

Table 5.9. **Percentage change in MP indicators for households relocated to expert planned settlements**

Change category	D_{work} (diff)	$D_{education}$ (diff)	D_{others} (diff)	T_{work} (diff)	$T_{education}$ (diff)	T_{others} (diff)	C_{work} (diff)	$C_{education}$ (diff)	C_{others} (diff)
Total decrease	14.9%	22.9%	58.2%	14.4%	21.9%	52.2%	10.4%	2.5%	12.4%
No change	2.49%	43.28%	8.96%	3.48%	42.79%	7.96%	28.36%	93.53%	65.17%
Total Increase	82.6%	33.8%	32.8%	82.1%	35.3%	39.8%	61.2%	4.0%	22.4%

Source: Anand, 2007

Table 5.9 shows that the mobility indicators for travel to work – distance, time and cost – have increased for 83%, 82% and 61% of the households respectively. The distance, time and cost for education have not changed for 43%, 43% and 94% of the households respectively and have increased for 34%, 35% and 4% of households respectively. Regarding travel for other purposes, there is a decrease of distance and time for 58% and 52% households respectively but no change in cost for 65% of households.

The results of the study show that for the poor households, which are not relocated to new areas, there is no significant impact on the indicator of mobility. The construction of metro line does not change their mobility patterns. However, since the bus routes and location of bus stops have been changed, these households face reduced access to transport services. With regard to the accessibility of the households, while the land use accessibility remains unchanged, the transport accessibility has changed as distance to the bus stops has increased for 19% of the households and bus services have become non-existent for 33% of the households.

On the other hand, for poor households relocated to the new areas, there has been a significant impact on the indicators of accessibility and mobility. The land use accessibility has deteriorated as distance to schools, health services and other urban services have increased for 52%, 63% and 52% of the households respectively. The transport accessibility has deteriorated even more as distance to bus stop has increased for 72% of the households and the bus frequency has decreased, on an average, from 5 minutes to 63 minutes (almost 13 times). The mobility of the households has increased significantly. The PCTR for work has increased for 49% of the households and decreased for 30%, implying change in the number of trips made for work in the households. The share of NMVs amongst the mode used has decreased for 59% of the households. The mobility indicators for travel to work – distance, time and cost – have increased for 83%, 82% and 61% of the households respectively.

Sarma (2015) studied travel patterns of people living in informal settlements in Delhi in 2012. Travel diaries of 1 700 individuals revealed the importance of quick access to employment for the inhabitants of the informal settlements. This also explains why the informal settlements brave illegality in the face of hostile authorities to stay close to their employment opportunities and raises questions against rehabilitation of slums in remote corners of city with reduced access to employment and amenities (Anand and Tiwari, 2007). While planning rehabilitation of informal settlements, the authorities must consider the proximity to their employment lest their very employment opportunities are adversely affected. The study also found that travel cost places a burden on the travel options of the residents of informal settlements, which accounts for the heavy dependence on walking and non-motorized transport. The usage of even public transport has been very limited as it places a burden on their finances. This shows that facilities like metro rail system, which are more expensive than the city bus, have questionable utility in providing accessibility for a large section of population that are poor.

The study also found that in settlements that came up close to the resettlement colonies significantly reduce education and work trips. These are the settlements formed by the former dwellers of relocated informal settlements but were deprived of the government housing. After the forced evictions, generally these settlers try to find a place close to their community who are rehabilitated in to government built resettlement colonies far from their employment. We expect that those living in resettlement colonies also are likely to have the same socioeconomic characteristics as these people and suffer similar disadvantages. The survey showed that most of the travel by the inhabitants of informal settlement is performed by walking or bicycle, the male employees have a higher probability of performing work tours than females. Most of the tours made by the women employees have been found to be pedestrian tours and are short distance tours.

Table 5.10. **Travel characteristics of residents of informal settlements**

Type of employment	Average PT distance (Km)	Average PT travel time (Minute)	Average PT travel cost (INR)
Formal	14.4	70	28.3
Informal	9.7	62	12.3
Student	3.3	29	1.7
Total	7.1	47	8.9

Source: Sarma, 2015

Table 5.11. **Travel distance of residents of informal settlements**

Type of employment	Percentage of employees by tour distance (km)					
	0	0.4-2.0	2.1-5.0	5.1-10	>10	Total
Formal	1.0%	2.1%	1.9%	3.1%	3.9%	12.0%
Informal	5.7%	7.6%	7.7%	8.1%	9.0%	38.2%
Student	14.8%	23.0%	9.4%	1.0%	1.6%	49.8%
Total	21.6%	32.8%	19.0%	12.1%	14.5%	100%

Source: Sarma, 2015

Most of the resettlement colonies have been at the periphery of the city. Bhan and Shivanand (2013) note:

> "This peripheralisation has increased post-1990s, with resettlement colonies literally at the edge of the borders of Delhi. This is seen particularly in the case of Narela and Holambi Kalan/Khurd, where more than 25 000 families from 88 evictions were offered resettlement plots. These two resettlement colonies are at the farthest tip of the northern edge of Delhi. Similarly, the newest resettlement colony of Savda Ghevra, where more than 9 000 families have been offered plots since 2006, lies at the western edge of the border of Delhi. None of the resettlement colonies since the mid-1960s fall within the NDMC and Cantonment areas even though at least 48 evictions have taken place within these boundaries, indicating the premium that space holds in these areas. The increasingly peripheral location of resettlement colonies, along with the continuing practice of prioritising resettlement rather than in situ upgradation, is thus creating precisely the spatial segregation that the Master Plan Delhi, 1962) sought to avoid".

Bhan and Shivanand (2013) also found that the four primary uses of the land that has been made available after the eviction of slum dwellers are vacant land, road and related infrastructure, parks and playgrounds, and government infrastructure (Figure 5.1). Of former basti land, 17% has been used for road and related infrastructure, while 15% has parks and playgrounds on them. The rest have commercial/ office space, have been reoccupied by JJ clusters, are being used for commercial purposes, or have metro infrastructure, landfills, concrete residences, nurseries, or drain-related infrastructure.

Importantly, 25% of the recovered land remains vacant and unused. In the vacant land category, there are at least 51 evicted sites – accounting for the displacement of a minimum of 21 551 families – that have remained fully or partially vacant between four and 21 years. Of these, 19 sites have remained partially/fully vacant for at least 10 years. The presence of so many vacant land parcels that were used productively by the poor for housing and shelter before their "reclamation" is not just an indicator of the futility of so much of the displacement that has taken place in Delhi, but also makes a case for re-hauling the state's policy towards the land it owns and redefining the basis of the priorities on use of public land. Instead of displacing the poor to reclaim land that is not needed for any other immediate purpose, the state could have chosen to invest in upgrading the land.

Chennai evictions and resettlement:

Large scale resettlements have taken place in Chennai between 2004 and 2014. Alberts et al.(2015) note that although the policy was designed to improve housing conditions for slum inhabitants, it also meant that residents became isolated from the city in terms of geographic distance, and the social relations on which they had depended for work and income, consumption, social, and religious activities. Alberts et al.(2015) paper uses a relational understanding of resettlement and exclusion, by examining how women's spatial practices are embedded in their livelihood strategies, their decisions about efforts and cost versus access to resources, and the extent to which they are able to counter socio-economic and spatial exclusion. Studies on the effects of resettlements on livelihoods in the Chennai area emphasize the disruption residents face in the new locations because of the distances to former social and economic networks (Arabindoo, 2012; Van Eerd, 2008). They highlight the resident's agency and collective mobilization to organize basic amenities and facilities in the new areas (Van Eerd, 2008). They also highlight the lack of facilities linking resettlement areas to the rest of the city, especially in the first period. Choices made in seeking employment and location of employment are influenced by a wide range of factors, as shown by the study in the resettlement area Kanagi Nagar south of Chennai 10 years after its establishment (Coelho et al., 2013). These include household situations and combined responsibilities within and outside the household (especially for women). Women travel up to 25 km., and the study by Alberts et al (2015) finds that both work and social relations are maintained across these distances, as women frequent places in the city for work, family visits, education, visiting temples and churches. This implies that women have maintained or re-established their relations with the city. This result places the women from the fringe firmly back into the city. However, urban accessibility is strongly linked to transportation accessibility. The majority of women stay in and around Semmencherry, within a radius of 5 km. Timings of transportation, social safety, and health issues limit women's possibilities to utilize transportation in physical terms. Finances limit their possibilities further in accessing transportation. This implies that their overall time–space access is limited (Kwan, 2002). These findings are in conformity with several dimensions of Fereirra's conceptualization of "access" (Fereirra and Batey, 2007). With better transportation links in Semmencherry, women have more opportunities for extending their space-time paths. However, two groups of women with very different situations are found to do so. The women from extended families can use their access to expand their relations with the city, for both employment as well as for accessing other facilities and resources. Women from single-person households have no choice but to work and access work elsewhere in the city, juggling livelihoods demands. They find themselves overstretched, which generates health and safety issues. Cultural norms play an important part in limiting the mobility of the large proportion of women remaining within the immediate range of Semmencherry.

Lucas (2012) shows that transport-related exclusion is a combination of socio-economic barriers preventing marginalized groups from using public transportation and the absence of affordable, safe, and accessible public transportation. Alberts et al (2015) reaffirm that the removal of obstacles to travel to the city centre combined with sufficient social-economic resources are prerequisites for inclusion. Alberts et al (2015) suggest that the choice to travel is more complex and involves weighing different factors, such as household needs, opportunities, and preferences, against the background of the households' composition. The choice not to travel is not always made because traveling is impossible; women may choose not to travel because they invest their time and resources elsewhere.

Planning for the poor and failure of planning

Many issues condition planning's ability and willingness to support the urban poor in the Global South. Roy (2009) discusses several possible failings in the context of India. Amongst these are inadequate planning practice, failure to accurately forecast changing need and planning policy increasingly underpinned by the imposition of values based on neoliberal, capitalist-driven rationality, the latter noted repeatedly by others (Du Plessis, 2005; Fernandes, 2004; Roy, 2009). Both Shatkin (2004) and Fernandes (2004) highlight the political amnesia which seeks to disregard the existence of poverty through an apparent abandonment of place-based poverty alleviation policies. That planning does not simply forget the poor but, through dominant planning rationales, actually exacerbates their difficulties. These rationales are manifesting in the built fabric of cities through spatial policies which prioritise the needs and desires of the affluent (Fernandes, 2004). These policies have become the guiding norms of planning. Their use as standard processes and planning tools, without regard for their value or impact, allows little room for accommodating Watson's (2003) 'conflicting rationales' existing between different stakeholders in the urban arena.

Low-income settlements whether self-planned or by the experts as part of the resettlement process have similarities in some aspects and differences in many aspects. While density patterns and usage of space is somewhat similar, one of the most important differences is location of the settlement with respect to the city. The self-planned low-income settlements are mostly located near the city centre, commercial or industrial hub or formal planned residential areas. Figure 5.4 shows a Google view of a low-income settlement in south Delhi. The land use around the low-income settlement provides both formal and informal employment opportunities. Most of the work places can be accessed by walking or bicycles resulting in least amount of travel expenditures. Studies conducted by Sarma (2015) show almost 80% trips are walking trips in these settlements. The length of these trips is also less than a kilometre. The travel pattern of residents of low-income settlements that are at the periphery in the resettled colonies is different. Number of walking trips reduce and distance to work increases. Location of resettlement colonies have been decided primarily on the basis of inexpensive land. Proximity to employment opportunities is not the prime concern.

Figure 5.4. **Contiguous development of low-density, high income and high-density, low-income colonies (enclosed within red boundary) in southern part of Delhi**

Source: Sarma, 2015

The literature on transport-related exclusion provides insights into the relations between (lack of) transportation opportunities, spatial practices, and livelihoods. Its thrust is that residential locations removed from the city centre and its job opportunities result in isolation and poverty due to inaccessibility or high costs of transportation (Anand and Tiwari, 2006; Lucas, 2012; Olvera et al., 2008; Srinivasan et al., 2007; Srinivasan and Rogers, 2005; Ureta, 2008; Venter et al., 2007). Transport-related exclusion occurs when social and economic disadvantages overlap with insufficient access to transportation (Lucas, 2012). Several forms of exclusion are distinguished: physical and geographical exclusion, exclusion from facilities, economic exclusion, time-based exclusion, fear-based exclusion, and spatial exclusion (Church et al., 2000, Lucas, 2012). Especially women face limitations in their spatial practices and access to transportation caused by the combination of productive and reproductive tasks, geographic distances, cultural norms concerning the use of certain modes of transportation, safety concerns, costs, and gendered relations within the household (Anand and Tiwari, 2006; Astrop et al., 1996; Kwan, 2002; Lucas, 2011; Venter et al., 2007).

We summarise these findings with respect to housing location, land use patterns and transport options for inclusive urbanisation: housing of low-income households and presence of slums or informal settlements in cities has been one of the major concerns of urban planners and policy makers since 1950s. The policies have ranged from forced evictions to in situ upgradation as the preferred option. Most policies have focused the need for affordable decent housing and ownership of land and access to basic amenities. Housing banks have been set up for easy financing and better rehabilitation policies. However, these policies have missed the strong link between housing location-access to livelihood-affordable transportation options and activity patterns of low-income households. As shown by Sarma et al (2014) employment pattern of low income households have to be understood differently. The destinations change as per the requirement of the job. Very often the destinations are the formal planned residential locations. Proximity to employment (formal and informal) is the most important factor influencing the choice of slum location. Policies focusing on land ownership and affordable housing have missed the link between location and livelihood.

Access to public transport systems like metro or bus system seems to be a weak option for addressing the exclusion created by land use policies. A subsidized public transport does not address the time poverty faced by many households and the flexibility required for multitasking, combining household chores with employment. Access to employment and other activities have to be ensured by improving pedestrian and bicycle facilities.

It is thus recommended that the new planning guidelines are framed for resettlement programs by learning from the self-planned settlements (slums) in order that the needs and requirements of the people are taken into account. Proximity to formal employment reduces dependency on motorized modes and reduces exclusion. This is more important for women who are involved in multitasking. More efforts are required to understand the factors which have resulted in failure of in situ development of slums or informal settlements.

References

Ahluwalia, I.J. (2011), HPEC Report on Indian Infrastructure and Services.

Anand, A. & Tiwari, G. (2007), Socio-Economic Impact Assessment (SEIA) Methodology for Urban Transport Projects: Impact of Delhi Metro on the Urban Poor. Doctor of Philosophy Indian Institute of Technology, Delhi.

Anand, A. and Tiwari, G. (2006), "A gendered perspective of the shelter–transport–livelihood link: the case of poor women in Delhi", *Transport Reviews*, 26(1), pp.63-80.

Astrop, A., Palmer, C. and Maunder, D. (1996), "The urban travel behaviour and constraints of low income households and females in Pune, India", National Conference on Women's Travel Issues, Baltimore, Maryland.

Banerjee-Guha, S. (2002), "Shifting cities: urban restructuring in Mumbai", *Economic and Political Weekly*, pp.121-128.

Bardhan, R., Sarkar, S., Jana, A. and Velaga, N.R. (2015), "Mumbai slums since independence: Evaluating the policy outcomes", *Habitat International*, 50, pp.1-11.

Barter, P. (2002), "Linkages between Transport and Housing for the Urban Poor: Policy Implications and Alternatives", Discussion paper prepared for the United Nations Centre for Human Settlements, (Habitat), Nairobi.

Bhan, G. and Shivanand, S. (2013), "Settling the city. Analysing displacement in Delhi from 1990 to 2007", *Economic and Political Weekly*, 48(13), pp.54-61.

Census of India (2011), "Census of India 2011: Provisional Population Totals", Office of the Registrar General & Census Commissioner, India, New Delhi, Paper 2, Volume 1 of 2011.

CGDR (2011), "Slums of Delhi", Center for Global Development Research, New Delhi.Chand, S. 2008, Within urban settlements in Honiara and Port Moresby, Volume two 85.

Church, A., Frost, M. and Sullivan, K. (2000), "Transport and social exclusion in London", *Transport Policy*, 7(3), pp.195-205.

Coelho, K., Venkat, T. and Chandrika, R. (2013), "Housing Homes and domestic Work: A study of Paid Domestic Workers from a Resettlement Colony in Chennai", *Economic & Political Weekly*, 48(43), p.39.

DDA (1962), Master Plan, Delhi Development Authority, https://dda.org.in/planning/mpd-1962.htm

Das, P.K. (2003), "Slums: the continuing struggle for housing. Bombay and Mumbai", The City in Transition Eds S Patel S, J Masselos (Oxford University Press, New Delhi) pp, pp.207-234.

du Plessis, C. (2005), "Action for sustainability: preparing an African plan for sustainable building and construction", Building Research & Information,33(5), pp.405-415.

Dupont, V. (2008), "Slum demolitions in Delhi since the 1990s: an appraisal", *Economic and Political Weekly*, pp.79-87.

Fernandes, K. (1998), "Forced Evictions and Housing Rights Abuses in Asia (Second Report 1996 - 1997)", City Press, Karachi, Pakistan.

Fernandes, L. (2004), "The politics of forgetting: Class politics, state power and the restructuring of urban space in India", *Urban Studies*, 41(12), pp.2415-2430.

Ferreira, A. and Batey, P. (2007), "Re-thinking accessibility planning: A multi-layer conceptual framework and its policy implications", *Town Planning Review*, 78(4), pp.429-458.

GNCTD (2013), Economic Survey of Delhi 2012-13, Government of National Capital Territory, Delhi, New Delhi.

Gopalan, P. (1998), "Circumscribed Existence: Women's mobility and settlements development", In SUSTRAN Network General Assembly, June 2 - 5, Manila, Mumbai: Swayam Shikshan Prayog - SSP.

Habitat International Coalition (2002), "Restructuring New Delhi's Urban Habitat: Building an Apartheid City?", Report on the resettlement process of Delhi, India 5.

Hazards Centre (2001), "Manual for People's Planning: A view from below of Urban Existence in Delhi", report, Hazard Centre, Delhi

Hazards Centre (2003), "A people's housing policy: The case study of Delhi", Hazards Centre, New Delhi.

Ibrahim, I., Aziz, N.A., Hussain, F., Aminudin, N., Yahya, M., Young, A., & Suleiman, A.I. (2012), "Issues and Policies on the Aftermath of Squatters Resettlement: A Case Study on Kg. Desa Hormat Tambahan, Selangor. Procedia", *Social and Behavioral Sciences*, 36, (0) 698-706.

Immers, B. & Bijil, J. (1993), "Slum Relocation and NMTs in Bangkok", *Transportation Research Board*, Paper # 93CF105.

Kundu, A. (2006), "Trends and patterns of urbanization and their economic implications", *India infrastructure report*, 2006, pp.27-41.

Lucas, K. (2012), "Transport and social exclusion: Where are we now?", *Transport policy*, 20, pp.105-113.

McKinsey & Company (2009), "Environmental and energy sustainability: An approach for India."

Mukhija, V. (2001), "Enabling slum redevelopment in Mumbai: policy paradox in practice", *Housing Studies*, 16(6), pp.791-806.

Mukhija,V. (2004), "The contradictions in enabling private developers of affordable housing: a cautionary case from Ahmedabad, India", *Urban Studies*, 41 (11) (2004), pp. 2231–2244.

NBO (2010), "Report of the committee on slum statistics/census, National Buildings Organization", Ministry of Housing and Urban Poverty Alleviation, Govt of India, New Delhi.

Neuwirth, R. (2005), Shadow Cities: a billion squatters, a new urban world NewYork, Routledge.

Nijman, J. (2008), "Against the odds: Slum rehabilitation in neoliberal", *Mumbai Cities*, 25(2), pp.73-85.

Nuworsoo, C., Golub, A., & Deakin, E. (2009), "Analyzing equity impacts of transit fare changes: Case study of Alameda, Contra Costa Transit, California", *Evaluation and Program Planning*, 32, (4) 360-368.

O'Hare, G., Abbott, D. and Barke, M. (1998), "A review of slum housing policies in Mumbai", *Cities,* 15(4), pp.269-283.

Olvera, L.D., Plat, D. and Pochet, P. (2008), "Household transport expenditure in Sub-Saharan African cities: measurement and analysis", *Journal of Transport Geography*, 16(1), pp.1-13.

Palmer, C. J., Astrop, A. J., & Maunder, D. A. C. (1997), "Constraints, attitudes and travel behaviour of low Income households in two developing cities", *Transport Research Laboratory*, TRL Report 263.

Palmer, C., Astrop, A., Babu, M., & Maunder, D. (1996), "The travel behavior of households in pune", International Symposium on Infrastructure of the Future, Bangalore, India, 2S -29 November, Transport Research Laboratory.

Patel, S.B. (1996), "Slum rehabilitation in Mumbai: possible if done differently", *Economic and Political Weekly*, pp.1047-1050.

Planning Department (2004), "Economic Survey of Delhi 2003-04", Planning Department, Government of National Capital Territory, Delhi, New Delhi.

Ramanathan, U. (2005), "Demolition drive", *Economic and Political Weekly*, pp.2908-2912.

Rao, K.R. (2014), "Article: Justice to women", Praja Shakthi Newspaper, Rajamundry (p. 16).

Risbud, N. (2003), The case of Mumbai, India. Understanding slums: case study for the Global Report on Human Settlements.

RITES (1998), "Traffic and Transportation Policies and Strategies in Urban Areas in India", Ministry of Urban Affairs and Employment, Government of India, Final Report.

Roy, A. (2009), "The 21st-century metropolis: new geographies of theory", *Regional Studies*, 43(6), pp.819-830.

Sarma, SSLN (2015), "Travel demand estimation of low income households", Case study Delhi, Ph.D. Dessertation, Transportation Research and injury Prevention Programme, Indian Institute of Technology Delhi, India.

Shatkin, G. (2014), "Contesting the Indian city: Global visions and the politics of the local", *International Journal of Urban and Regional Research*, 38(1), pp.1-13.

Siroha, P. (2001), "Evaluation of Slum Upgradation Strategies in Delhi", School of Planning and Architecture.

Sivam, A. and Karuppannan, S. (2002), "Role of state and market in housing delivery for low-income groups in India", *Journal of housing and the built environment*, 17(1), pp.69-88.

Srinivasan, S. and Rogers, P. (2005), "Travel behavior of low-income residents: studying two contrasting locations in the city of Chennai, India", *Journal of Transport Geography*, 13(3), pp.265-274.

United Nations (2014), *World Urbanization Prospects 2014: Highlights*, United Nations Publications.

Ureta, S. (2008), "To move or not to move? Social exclusion, accessibility and daily mobility among the low income population in Santiago, Chile", *Mobilities*, 3(2), pp.269-289.

Van Eerd, M. (2008), "Policy interventions and grassroots initiatives: Mismatches in a relocation project in Chennai, India".

Venter, C., Vokolkova, V. and Michalek, J. (2007), "Gender, residential location, and household travel: Empirical findings from low income urban settlements in Durban, South Africa", *Transport Reviews*, 27(6), pp.653-677.

Watson, V. (2003), "Conflicting rationalities: Implications for planning theory and ethics", *Planning theory & practice*, 4(4), pp.395-407.

Chapter 6
Balancing financial sustainability and affordability in public transport: The case of Bogotá, Colombia

Camila Rodríguez Hernández
The World Bank Group, Washington DC, United States

Tatiana Peralta-Quiros
The World Bank Group, Washington DC, United States

In order to meet the challenges of providing affordable public transit services for the urban poor and at a cost that doesn't impinge on the system's financial sustainability, cities can consider setting fares at "cost recovery" levels for the majority of the population and targeting subsidies to those who need them most. Bogotá is a case in point—the new public transport system was designed so fares are set close to "cost recovery" levels to aim for greater financial sustainability. To provide affordable services, the city leveraged the adoption of smartcards in its new public transit system and the country's poverty targeting instruments to implement a pro-poor public transit subsidy. This chapter presents a critical analysis of Bogotá's experience with trying to balance financial sustainability and affordability. The chapter describes some of the features of Bogota's tariff policy, namely, the concept of tariff set at "cost recovery" levels and lessons learnt in trying to achieve financial sustainability. The chapter also lays out the rationale, design and implementation of Bogota's pro-poor public transit subsidy, and the subsidy's impact on its beneficiaries.

Introduction

Public transport is an important mode of transport, especially for low-income populations. Cities, however, struggle to provide public transport services for fares that are both affordable and financially sustainable. Since meeting both goals is quite difficult, transport systems, either end up relying on high levels of subsidies or charging transit fares that are too expensive for the city's poor.

As a result, some city's transport systems use low fare levels (examples are Buenos Aires or the Mexico City subway), which require high amounts of public subsidy. Other cities use higher and thus more sustainable fares, but risk excluding the poor from public transport. The latter is the case in Bogotá, Colombia, where fares for its new public transit system are set high, close to cost-recovery levels, which may be unaffordable for part of the population. Bogotá is currently implementing its Integrated Public Transport System (*Sistema Integrado de Transporte Publico, SITP*), which will integrate under a single fare, operation, and infrastructure all its Transmilenio's Bus Rapid Transit (BRT) corridors with the traditional bus system, the bike network and, in the future, Bogotá's first subway line. One of the prominent features of this public transit reform process—both in Transmilenio and the SITP— has been the profound change in the business model and incentive structure for public transport service provision. These new incentives are embedded in the concession contracts for service provision, and are linked to the underlying concept of a tariff policy set at "cost recovery". Against this backdrop, Bogotá has tried to balance the needs for financial and social sustainability by setting fares at cost-recovery but then offering targeted subsidies for specific segments of the population.

This chapter presents a critical analysis of Bogotá's experience with trying to balance financial sustainability, by setting fares close to cost recovery levels, with affordability, by implementing targeted demand side subsidies for public transit. The chapter describes some of the features of Bogotá's tariff policy in the context of the ongoing reforms; namely, the concept of tariff policy set at "cost recovery" levels, and explains how a structured process that incorporates incentives for efficiency via concession arrangements for service provision was developed. Against this backdrop, the chapter also explains how the city tackled some of the affordability constraints of the poor, by developing a targeted public transit subsidy that leveraged the country's poverty targeting system and database, and the progressive adoption of smartcards in its public transit system to design a pro-poor targeted subsidy scheme.

The first section of this chapter provides a literature review on the case for supply and demand side subsidies in public transit, particularly for a developing country context. The second section describes how Bogotá developed a structured process to set fares set close to "cost recovery" in its new transport system, and some of the lessons learnt in aiming for greater financial sustainability. The following sections describe the design, implementation and impact of Bogotá's pro-poor subsidy scheme. This section also briefly explores the results of the impact evaluation that analysed the determinants of opting to request the subsidy and the subsidy's impact on user's labour market outcomes. The chapter concludes with some recommendations in terms tariff policy, financial sustainability and design of targeted pro-poor subsidies.

Subsidies in public transit - the case for supply and demand side subsidies

A critical policy question is whether public transit subsidies should be given on the supply or on the demand side. There are three primary theoretical justifications for supplyside public transit subsidies. First, it is argued that such subsidies reduce the cost of environmental externalities; second, that they exploit users economies of scale; and third, that they increase cost efficiency of public transit systems as a whole. The first argument is based on the idea that subsidies can reduce congestion by shifting use from individual automobiles to public transport (here, subsidies act as a second-best alternative to marginal social cost pricing of road use). However, this hinges on the attractiveness of public transport to current automobile users, and the cross-elasticity of demand has been found to be typically low (Toner 1993, Wardman 1997, Paulley et al 2004, Litman 2015). The second argument, based on the so-called Mohring effect (Mohring, 1972) which describes the observation that there are increasing returns to scale for urban transit services because the frequency of a service increases with demand, and so increases in demand reduce the time costs associated with waiting and transfers. This, however, relies on excess supply side capacity. Finally, the cost-efficiency argument posits that public transit subsidies can reduce total transport system costs through greater economies of scale due to transport system intermodality (Train 1977).

Empirically, under certain conditions supply-side subsidies that help improve the quality of service by increasing service frequency have been found to be socially desirable (Dodgson 1987; Glaister 1987, 2001; Savage and Schupp 1997; Small and Gómez-Ibáñez 1999; Savage 2008; Parry and Small 2009). However, some disagree that providing supply side subsidies are favorable because of the negligible effects on the quality of service and the associated adverse effects on operational efficiency. Studies of subsidy impacts (Altshuler et al, 1981; Meyer and Gomez Ibanez, 1981; Hilton, 1974l Hamer, 1976; Webber 1976) have concluded that direct benefits to transit rides have been small relative to the increase in the subsides and that alleged environmental and secondary economic benefits are negligible or no existent. Goldman and Wachs (2003) have shown that, in the United States, transit subsidies have resulted in system inefficiencies because of inadequate allocation mechanisms and incentives for cost-efficiency, and failure to improve level of service via increased frequencies or fare reduction. Pucher, Markstedt and Hirschman (1983), found that US Federal subsidies and dedicated state and local subsidies had a slight cost-inflationary effect on the cost of providing transport services, further exacerbating increases in cost. In the US during periods when subsidies have increased most, productivity has declined, causing costs to grow more rapidly. Obeng (2009) finds that transport subsidies are inadequately used, and points to the inefficiencies and risks associated with the perverse incentives created by supply-side subsidies. A report by TRRL (1980) estimated that up to half of the costs of subsidies in the UK in the eighties were estimated to “leak” to operators in the form of high wages or inefficient operating arrangements.

In developing country contexts, the arguments against supply-side subsidies can further be extended by the need to limit the fiscal burden, given limited resources and competing needs; and the need to focus subsidies where they are most needed socially (Gwilliam 2012, Serebrisky, Gomez-Lobo, Estupinan and Munoz-Raskin, 2009). Hence, to balance the needs for economic and social sustainability, ideally cities should try to set fares close to cost-recovery, but offer targeted demand-side subsidies for specific segments of the population that face an affordability constraint. This, however, introduces additional complications, and the experience thus far with demand-side subsidies is mixed; these subsidies have not always led to the intended results because of difficulties with accurately identifying the target population, potential abuse of the subsidy such as transferring the subsidy to an unintended recipient, and large errors of exclusion or inclusion of the target population (Box 6.1). There is also very little evidence on the impact that such subsidies have on the lives of target beneficiaries.

Box 6.1. **Lessons from "first generation" demand-side subsidy programs**

Several types of subsidies have been used to support low-income users of public transport. While well-intended, the subsidies provided through these "first generation" subsidy programs do not always reach the target audience and may even have unintended outcomes. The following are four types of subsidy programs and lessons that have been learned from their implementation:

- **Vale-Transporte.** This subsidy program in Brazil caps commuting expenses for workers in the formal economy to 6% of their wages, with employers paying for the rest as a tax-deductible expense. Employees could request to join the program. This makes formal workers somewhat immune to higher transit tariffs, while providing no relief to workers in the informal sector (who constitute about 57% of the labor force nationwide). The government paid about 35% of the cost in foregone tax revenue. This subsidy created a substatintial black market for reselling 'free' tickets.

- **Cable cars (telefericos) and feeder lines.** Teleferico services in Rio de Janeiro (Brazil) and Medellin (Colombia) provide free transport to and from certain poorer neighborhoods using cable cars. In Bogotá (Colombia), free "feeder lines" connect certain neighborhoods to the city's Transmilenio BRT system. While providing free services to poorer neighborhoods increases access, this kind of subsidy has significant exclusion errors in that it excludes a large number of low-income households living elsewhere in the city. The subsidy may also exacerbate a city's already existing spatial segregation.

- **The Bilete Unico and Integrated Fares that subsidize transfers.** The Bilete Unico system in Brazil, and integrated fare systems in Bogotá and Santiago, use a card to cap the fare for multi-modal trips. The program subsidizes transfers, which (in an urban structure with most of the poor living in the city's periphery and often needing to transfer) overwhelmingly supports low-income households. It however also reinforces tendencies for urban sprawl and is characterized by errors of inclusion.

- **Subsidized fares for the elderly, students, war veterans, and other categories.** While an important way to improve transport access for target groups, this kind of subsidy suffers from both inclusion and exclusion errors: many poor might not fall into one of these categories and people who do may not be poor.

Source: Mehndiratta et al(2014)

Building on the experiences of these "first generation" subsidies, Bogotá has recently innovated in targeted demand-side subsidies for the poor. The following sections explain how Bogotá implemented a structured process to set fares at "cost recovery" levels and how it dealt with an affordability constraint for the poor by designing and implementing targeted demand-side subsidies.

The basics of Bogotá's tariff policy and the concept of cost recovery

Until the development of the Transmilenio system in 2000, all public transportation in Bogotá was operated under a system characterized by an inadequate incentive structure that led to an oversupply of buses, increased congestion, reduced vehicle safety and low-quality service. Bus companies owned the routes granted to them by the city government but were not required to own the bus fleet. Individual investors owned buses, and bus companies rented out to bus owners the right to operate a certain route. This arrangement induced bus owners to compete against other buses, irrespective of demand patterns, as their revenue and the wage of the bus driver was directly related to the number of passengers carried. Bus companies' main assets were their routes as they rent them out to bus owners, so they had the incentive to lure as many buses as possible to operate their routes. The incorporation of a number of buses beyond those required to serve the market led to excessive competition, locally known as "the penny war" (guerra del centavo) because drivers literally fought for each prospective passenger (World Bank 2012).

In response to these shortcomings, by the end of the 1990s, the government of Bogotá began to explore alternative ownership models and incentive structures that maintained the benefits of privatization but improved service provision. One such ownership model was concession contracts for service provision. In this system, a competitive bidding process is used to determine which bus operators will have the right to operate a route or a number of buses. The concession is for a limited period of time, which ideally coincides with the useful lifespan of the fleet, as opposed to the lifetime permits offered in the traditional model. Bus operators, in turn, need to own the bus fleet and operate it under close supervision and regulation from the public sector, which determines whether operators supply the scheduled service. On the infrastructure side, the system uses exclusive bus ways, high-capacity buses, a centralized fare collection system based on the use of smartcards and a fleet control system (World Bank 2011). This new ownership model, incentive structure and infrastructure provision was at the crux of the Transmilenio BRT system, implemented in Bogotá in December 2000.

There are several features of the basic tariff model developed in the context of Transmilenio and used subsequently in Bogotá's SITP and in all of the other Colombian BRT systems that are worth highlighting. The systems were designed to be operationally self-sufficient with fares set at "cost recovery" levels. At present, Colombian law (Law 86 of 1989, Article 14) requires that public transport systems operate in this manner and that city government does not subsidize the system. In fact, the law mandates that fares charged should be sufficient to cover the costs of operation, management, maintenance and replacement of the bus fleet. In order to determine the appropriate cost-recovery fare a structured process was developed that incorporated incentives for efficiency. The process is as follows, first, the public sector administrator designs the system and the operating plan. The public sector is also responsible for developing and maintaining the system infrastructure. The cost elements included are those associated with bus operations, fare collection and management, a trust agent (in charge of collecting revenue and then distributing payments to all agents) and a public sector system administrator in charge of planning and managing the system. Each of these elements (except the public sector administrator costs, which are estimated and added to the other costs) is then bid out separately. In the case of bus operations, there is a strong focus on keeping in the new system as far as possible, drivers and operators who were participating in the old traditional system. As such, owners and drivers are encouraged to organize into formal companies that then bid against each other (often with partners that could include operators from outside the city) for a share of the service. Lastly, a notional "technical tariff" is then estimated by summing up the winning-low bids for each cost element (plus the per ticket costs estimated for the administrator) and dividing that by the expected ridership. In other words, the "technical tariff" or the tariff that allows for cost recovery is an indicative tariff that captures the required average revenue per ticket sold that is needed to guarantee that the remuneration of all of the system's service providers (bus operators, fare collectors, trust agent, planning agency) is covered, given a predetermined level of service.

Four features of this structure and the experience with this system in Bogotá are worth highlighting.

- First, in general, the creation of the notional "technical tariff" needed to operate the system at cost-recovery levels, constructed in a manner that incorporates incentives for efficiency for different stakeholders has been a useful and important development. While the user tariff needs to closely track the technical tariff, the city Mayor (who determines the user tariff) has some discretion on timing and level of adjustments. The result has been a system whereby (i) the need and level of user tariff adjustment needed has been important public information making at least somewhat easier the Mayor's task of adjusting fares; (ii) in Bogotá the system has gone through periods when the user tariff has been higher than the technical tariff – creating a surplus that has helped finance deficits in periods (like the present) where adjustments in the user tariff have lagged changes in the technical tariff.

- Second, the ridership estimates play a critical role in determining the initial technical tariff. In the case of the initial Transmilenio corridors, demand exceeded estimates, thus providing the system with surpluses in initial stages. In the case of the SITP actual ridership levels have been significantly lower than expected, leading to important deficits for the systems in initial stages. The experience clearly reinforces the need for high quality demand forecasts as an input into project structure.

- Third, it is the bidding process that guarantees efficiency in costs, and as such, the level of efficiency obtained depends on the competitiveness of the bidding process. Bus-operating costs constitute the bulk of the technical tariff (between 70-80%), and as described above the initial bidding process, while competitive is not truly open. To safeguard the interest and livelihood of the traditional and largely informal public transport sector, the tendering process includes prerequisites that protect sector incumbents. On one hand, given the complex social environment characterizing the traditional bus system in Bogotá, the ability to create some competitive dynamic is itself both difficult and commendable: in a similar environment in Mexico, the practice is to negotiate with no elements of a competitive dynamic. Compared to that, the practice in Bogotá provides an important incentive for efficiency in bus operating costs. However, a truly "competitive" and open tendering process is ultimately the best guarantor of efficiency. This suggests the need to ensure that initial contracts are of a reasonable duration and that once they expire they are followed by open competitive bidding processes. In reality, the initial contracts for Bogotá had duration of 12 to 14 years, but were extended by Transmilenio in a recent renegotiation. The SITP contracts have duration of 24 years. In the medium and long term, moving towards a system of re-competing concessions openly would be important to ensure system efficiency.

- A fourth element of the tariff system is "scope creep": more and more cost elements not directly related to operations have been loaded on the tariffs. In Bogotá the tariff is also paying for planning and supervision of the systems (by way of financing the BRT agencies, Transmilenio), bus scrapping costs (indirectly as part of bus operating costs) or infrastructure provision. Many of these costs are capital costs— bus scrapping, fleet renewal, infrastructure— and/or elements of the reform process –formal employment for bus drivers and maintenance personnel— that bring benefits not just to users but to society as a whole— pollution and GHG emission reduction, road safety. Thus, it is not clear that public transit users should have to pay for enhanced societal welfare or for non-operating costs. All in all, the fact is that for lack of more sustainable and secure sources of funding, the tariff has been used sometimes arbitrarily to finance a number of elements that are not direct "operating costs" and are placing strains on the financial equilibrium of the system.

Bogotá's pro-poor subsidy scheme

In order to meet the challenge of improving affordability to public transit for the poorest, Bogotá rolled-out in early 2014 a "pro-poor" public transit subsidy based on recent technical assistance provided by the World Bank (World Bank 2013). This work provided a better understanding of the poor´s travel patterns, the alternatives for targeting the subsidy, the implications on the system´s costs, and alternatives on how to implement the scheme. The following sub-section presents a framework for how Bogotá designed this scheme which is based of four key considerations: (i) understanding the current and expected travel patterns of potential beneficiaries; (ii) understanding who to subsidize and by how much; (iii)comparing system impacts and financial implications; and (iv) planning for implementation[1].

A framework for designing and implementing a targeted transport subsidy

Understanding current and expected travel patterns.

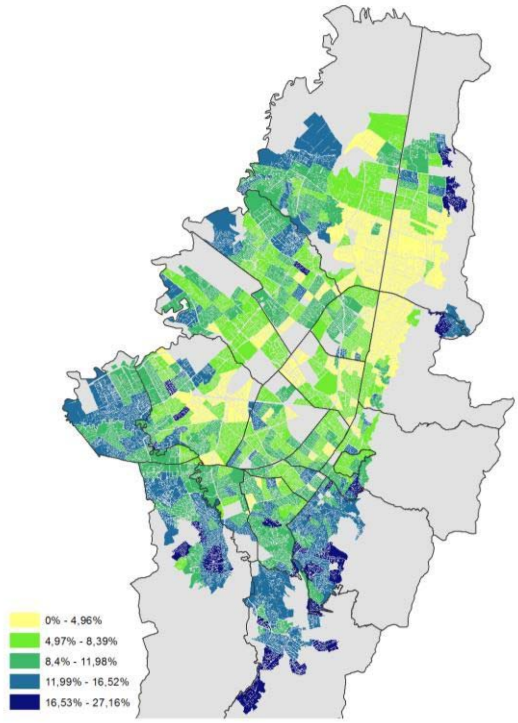
An important part of a successfully designed subsidy program is understanding how mobility constraints and poverty are interacting and how people, in particular the target population, currently travel and will likely travel under a subsidized scheme. Answering these basic questions, however, is not easy, as a significant mismatch exists between available data on travel patterns and data on poverty. While many cities collect travel survey data as part of their broader transport planning process, most of these surveys do not include good information on poverty— specifically poverty as measured by multidimensional factors. Likewise, poverty surveys rarely collect mobility data.

For Bogotá, data was analysed from the 2011 Mobility Survey, the Multi-Purpose Survey, as well as further analysis were performed to spatially correlate quality of life indicators with mobility patterns. According to Bogotá's 2014 Multi-Purpose Survey, which provides welfare and socioeconomic indicators for the city, households in the poorest areas of the city spend a greater percentage of their income on transport, between 16% to 27%, compared to a maximum of 4% in areas that are relatively richer (see Figure 6.1 and 6.2). Bogotá's 2011 Mobility Survey also corroborates this—the population in the lowest income strata usually travels less, and walks or bikes for longer trips.

Figure 6.1. **Number of trips and individual income intended for the transport**

Source: Bogotá Multi-Purpose Survey, 2014.

Figure 6.2. **Public transportation spending as a proportion of total household expenditure**



Source: Bogotá Multi-Purpose Survey, 2014.

Understanding who to subsidize and by how much.

Different kinds of subsidy schemes exist (including also the "first generation" schemes from Box 6.1) and which one fits best depends on the characteristics of the city population, the transport system, and transit users, as well as on political decisions related to the available resources and size of the target populations. A systematic comparison of alternative subsidy schemes, including (i) traditional socio-demographic subsidies (i.e., targeting specific groups such as the elderly or students); (ii) employer-based subsidies (which generally exclude the informal sector); (iii) spatial subsidies (e.g., subsidies for trips that begin or end within certain pre-determined stations); and (iv) schemes that target the poor directly (proxy-means tested), can provide a sound basis for discussion and decision-making. Ideally, this assessment will cover both affordability benefits to the target population and financial objectives for the transport system.

For the case of Bogotá, two targeting alternatives were analysed — proxy means tested by using Colombia's national targeting system, SISBEN ((Sistema Nacional de Selección de Beneficiarios, see Box 6.2), or geographic targeting. In general, the goal was to minimize the subsidy's errors of inclusion (percentage beneficiaries that are unintended) and exclusion (percentage of intended beneficiaries left out) to ensure the subsidy reached the intended audience. In Bogotá, several technical and political reasons led to using the SISBEN as the targeting instrument. First, this instrument is used in all of Colombia's social safety net programs, and thus provided a transparent and well-known means to administer this new subsidy scheme; second, although Bogotá is spatially quite fragmented, and a geographic subsidy could potentially be implemented, the administration felt it could lead to further spatial segregation and fragmentation.

Box 6.2. **Proxy means testing for targeting – Using Colombia's SISBEN Instrument**

Colombia has used two methods for targeting social spending: the geographically based Socio-economic Stratification and the proxy means tested System for Selecting Beneficiaries of Social Spending (SISBEN, in Spanish). The stratification instrument classifies neighborhoods and rural areas in strata based on the external characteristics of houses and neighborhoods. It is used to target subsidies for potable water, electricity and a variety of other small subsidies, by central and local governments. In order to more efficiency target other subsidies including health insurance, scholarships, conditional cash transfers, Colombia's National Planning Department (DNP) introduced the SISBEN in 1994. The general objective of SISBEN was to establish a technical, objective, equitable and uniform mechanism for selecting beneficiaries of social programs to be used by all government levels.

The SISBEN utilizes a proxy-means test in order to determine whether an individual is eligible for assistance based on whether he possesses the means to do without that help. The methodology relies on several socio-economic indicators—or proxies— (household demographic composition and marital status, education, employment, income, possession of goods and assets, and dwelling characteristics) to estimate household welfare. (World Bank 2005)

The SISBEN database is created in a two-step process. Initially, a statistical model is used to determine the variables that are representative of welfare level. These are then used to create the SISBEN questionnaires. In order construct the SISBEN database, municipalities identify poor areas to be surveyed using a variety of information to produce local poverty maps. Municipalities then launch the survey operation to apply SISBEN questionnaires to all residents in selected areas. People who are not surveyed because they do not live in the pre-selected survey areas can apply for SISBEN application at the municipal offices. The SISBEN Index gives a continuous score from 0 to 100 (from poorest to richest) divided into six brackets or levels (1 to 6). Levels 1 and 2 are people in poverty and able to receive most national and local programs.

The SISBEN methodology is updated every three years. The newest methodology for the SISBEN III, updated in 2015, applies a multidimensional concept of poverty and includes elements of the vulnerability conditions of the population. Most importantly however, the new SISBEN captures a larger degree of detail and representation in the ranges of scores used to deliver social programs. Whereas before, the methodology provided generalized levels for all social programs, the SISBEN III allows each program to define its own cutting points based on the objectives of the program, and the characteristics of the population. This allows each program to create a threshold score that best responds to the concept of poverty, deprivation, or vulnerability, of each program; in order to include the greatest amount of the population that requires the program and prevent the entry of people that do not need it. (DNP 2015)

Based on a 2009 World Bank report, proxy-means tested has proven to work particularly well in countries with high levels of informality and where personal and household income is difficult to verify. Proxy-means tested instruments are not unique to Colombia; they have been used in Countries such as Chile, Congo, Costa Rica, Cambodia, Indonesia, Mexico and Zambia.

Determining how much to subsidize — that is, the impact of changes in fare prices on ridership, is complicated, as almost no empirical data exists on the response of the target population to significant changes in fare levels, in particular reductions in fares. Moreover, most empirical estimates of fare elasticity are valid only for small changes in fare levels. In the case of Bogotá, information on the fare elasticity for different beneficiary groups (those currently using the integrated new SITP system; those using the traditional public transit system; and those currently not able to afford public transport) was needed to discuss alternatives of how much to subsidize and to assess the impact of the subsidy scheme on system revenues, costs, and operating conditions (see Box 6.3). Because only limited data was available about the way potential beneficiaries would react to changes in fares (either by increasing or decreasing certain trips or changing modes of transport), simple correlations were estimated using the city's mobility survey to get a sense of the direction and magnitude of their response to fare price changes, which was then followed by a price elasticity analysis using seven years of data from smart card swipes and user entries at different Transmilenio stations in one of Bogotá's poorest neighbourhoods, Usme. This time series included 2012, when Transmilenio applied a differential fare scheme that provided rebates for off-peak travel. Overall, the result of these different methodological approaches pointed to the fact that price elasticity for potentially poor beneficiaries was rather low (World Bank 2013).

Financial impacts-- comparing system impacts and financial implications

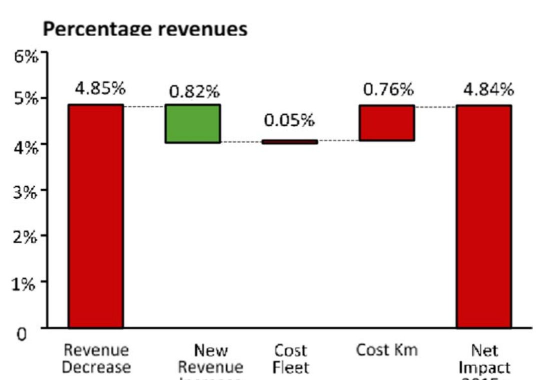
Assessing the financial sustainability of different subsidy schemes was a critical part of the planning and design process. The main objective was to determine the implications of the new subsidy scheme on overall ridership, system revenues, operating costs, and other conditions of the public transport system. In Bogotá, for instance the total revenue impact was a combination of the additional revenue obtained from new trips taken by beneficiaries, the foregone revenue resulting from subsidizing beneficiaries that are currently using the system, and any additional costs incurred by operators from increasing service supply to cater to new trips (Box 6.3). Elasticity estimates were also used in this part of the exercise to quantify these effects.

Box 6.3. **Assessing the effect of a targeted demand subsidy in Bogotá's SITP**

In Bogotá, the design of a targeted subsidy scheme required carrying out an assessment of the scheme's potential impact on Transmilenio and SITP system conditions (operating revenues, costs, and operational constraints) under the current contractual arrangements.

As shown in Figure 6.3, the analysis suggested three linked outcomes of the implementation of the planned subsidy scheme. First, partial revenue would be foregone for about 650 000 trips (about 4.9 percent of ridership) currently made by the intended beneficiaries annually who paid full fare. Second, additional revenue would be generated by 110 000 new trips a year, as a result of subsidy beneficiaries making more trips, adding 0.8% to ridership and revenue annually. Third, these additional revenues from new trips would require additional system capacity, leading to new costs — additional cost/fleet and cost/km logged —roughly equivalent (and thus canceling out) the additional revenue. These effects are a direct result of the fare elasticity of different beneficiary cohorts.

Figure 6.3. **Evaluating financial and operational impacts: Impact of a 30% face discount for the poor in Bogotá**



Source: Shomik et al (2014)

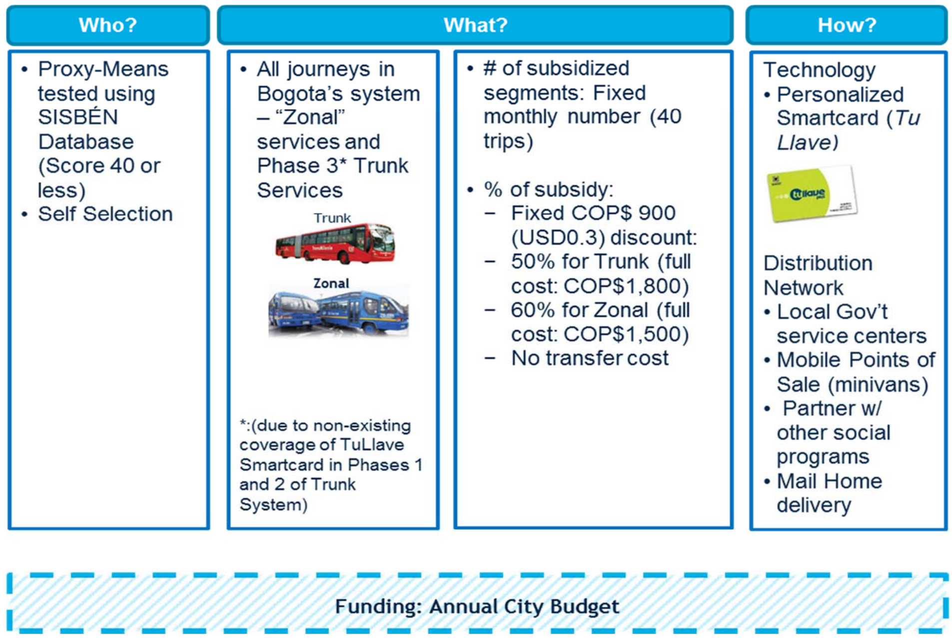
Finally, in terms of financial impacts and system comparison, attention was paid to funding sources of a subsidy scheme, which ideally would not come from the public transport revenue, to not put further financial strains on the system. Although for the case of Bogotá general city budget was used to launch the scheme, discussion on alternative sources of financing, such as generating cross-subsidies from private vehicle users (parking charges, congestion pricing, and fines) to public transit users, is critical. Using those funds to improve public transit systems, and financing targeted subsidy schemes, is ideally the more sustainable and economically sound financing scheme for these sorts of policies.

Planning for implementation

Several implementation arrangements and rollout strategies were analysed for Bogotá-- self-selection, dissemination and registration, subsidy delivery arrangements, sharing of databases between government entities, etc. Furthermore, since one specific element of the Bogotá subsidy scheme was to leverage the progressive adoption of the smartcard (TuLlave Card), mechanisms to control subsidy abuse were analysed and adopted via the modification of the smartcard card protocols (inclusion of time windows, restriction on number of station validations, number of trips, etc.).

Figure 6.4 summarises the final design and implementation arrangements adopted. Citizens that live in Bogotá, that do not receive other concessional fares and have a SISBEN score of 40 or less can opt to request a public transit subsidy. The subsidy amounts to COP 900 (Colombia peso), equivalent to almost USD 0.30 (the average fare is USD 0.55), and is capped at 40 trips per month (on average this represents a 45% discount for trunk services, and 53% discount for feeder services). The card is also programmed with one free “credited” trip that can be used when the card is loaded, and once validated in a station, cannot be reused within a 30-minute window. Thus, people who are eligible have to request the subsidy, and the card is programmed with certain features to prevent subsidy abuse... Although the SISBEN dataset has the address of the potential beneficiary and in theory cards could be mailed to the entire potential beneficiary universe, Bogotá decided to opt for the mechanism of self- selection during initial subsidy roll-out to manage potential subsidy abuse, get a better sense of the resources needed and mitigate fiscal impacts, as every card that is issued needs to be paid to the fare collection concessionaire. Potential beneficiaries can obtain the personalized subsidy card in the local government’s city centres, Transmilenio Terminal depots, or using the mobile (minivans) points of sales. Once a potential beneficiary ID is validated against the SISBEN database, the beneficiary receives the smartcard in about three business days.

Figure 6.4. **Design and implementation of the Bogotá SISBEN Subsidy**



Source: World Bank

As of July 2015, almost 300 000 (updating info with Tranmsmilenio) people had obtained the smartcard with the subsidy, and almost 200 000 (updating info with Tranmsmilenio) had actually used it. However, subsidized smart card use has been substantially lower than the potential beneficiary population (nearly 800 000 people).

Impact of targeted pro-poor public transit subsidies in Bogotá

As explored previously, there is very little evidence on the impact of targeted pro-poor subsidies on the lives of its beneficiaries. As a part of a larger impact evaluation published in this year's Transportation Research Record, we explored the determinants of opting to request the smartcard with the subsidy, the effects of the subsidy in the use of the system, and the subsidy's impact on user's labour market outcomes.

This impact evaluation explored the following questions: What are the determinants of user's "self-selection"? How did the use of the public transit system changed with the application of the subsidy? What are the causal links between the subsidy and labour market outcomes: employment and income? Two regressions, (linear and probabilistic) were used to identify the characteristics of individuals who choose to request the subsidized fare. A quasi-experimental technique was used for the impact assessment of the subsidy on the use of the system and on labour market outcomes. This research allows us to being to understand how to design targeted subsidies for maximum labour market outcomes

Determinants of user's "self-selection"

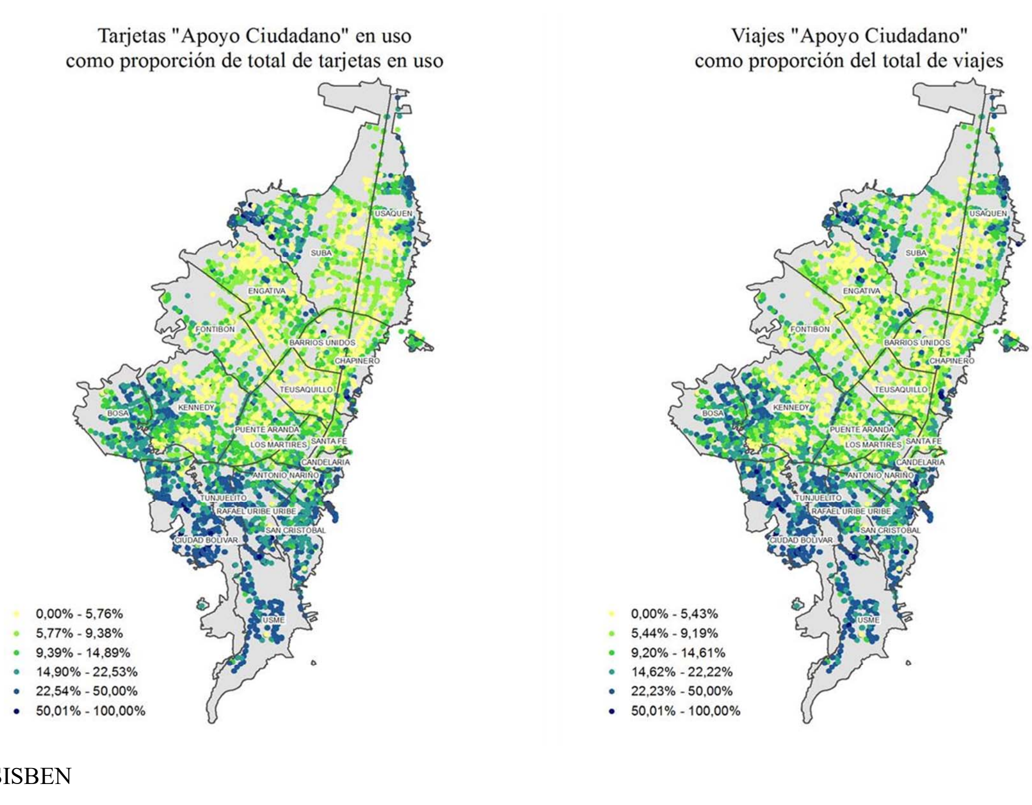
In terms of the determinants of "self-selection", the analysis pointed to three important elements that affected the probability of obtaining the subsidized cards: word of mouth, employment status and gender. People who had a large number of neighbours in the program were more likely to enrol. Therefore a dissemination campaign that focused at the neighbourhood level (significant resources have been used by the administration to do mass media campaigns), and expands the opportunities for individuals to obtain smartcard for the first time (scaling up for instance the minivan strategy in very poor neighbourhoods, with low accessibility) are likely to increase the percentage of the target population that enrols. Furthermore, people who are working are more likely to apply for the subsidy, this may reflect that those that are unemployed have other binding labour market conditions (eg. lack of proper skills), or that the subsidy is not sufficient (higher percentage of the fare needs to be subsidized) to deal with their mobility constraint. Women seem to be more resourceful The fact that women are more likely to opt for the subsidy also might corroborate the argument that women have different travel patterns, and generally travel more due to other household and non-employment duties, and thus would benefit more from subsidized travel.

Effect of the subsidy on the use of the transit system

The smartcard database provides a clear understanding of how travel patterns of the beneficiaries had changed with the implementation of the SISBEN subsidy.

The results demonstrated that the subsidy beneficiaries had an increase use of the public transit system. The SISBEN subsidy recipients have an increase in monthly trips of nearly 56% when compared to normal fare card use. This translates into 10 extra monthly uses of the system -- on average users had eight additional trips and two additional transfers. These findings show that the subsidy helps overcome the lower frequency of daily-motorized travel among the poor previously explored (Figure 6.5). Secondly, the increase in transfers is also interesting, because the subsidy does not affect its cost. The subsidy did not decrease the cost of a transfer, and therefore the increase in transfers might indicate that the users are learning how to take advantage of a multimodal system.

Figure 6.5. **Subsidized cards in use and subsidized trips as a proportion of total**



Source: SISBEN

Furthermore, we found no significant effects on the total transport expenses incurred by users being subsidize. The proportion of income spent on transport did not change significantly, despite the subsidy. Users appear to be using the system more.

Labour outcomes

In terms of the effects of the subsidy on labour market outcomes, the results demonstrate that the subsidy had a significant increase on the hourly earnings of informal workers. The increase in income is not associated with an increase in the number of hours worked per week; in other words, the effect is not, related to timesaving that allowed the individual to work for longer hours. Rather, it points to the complementarity between mobility and productivity of informal activities — the subsidy appears to be increasing productivity by allowing informal workers to have better mobility and accessibility to economic opportunities, and thus higher earnings. Several exercises were performed to verify and further understand these results; these exercises corroborated the effect of the subsidy on informal workers' hourly income. Heterogeneous effects show that the effect on income of informal workers is particularly high for those who, despite being informal, have a hierarchical working relationship with an employee. This may be an indication that the channel through which the subsidy has an effect is through the increased ease of time management.

Conclusions

In order to meet the challenges of providing affordable public transit services for the urban poor and at a cost that doesn't impinge on the system's financial sustainability, cities can consider setting fares at cost recovery levels for the majority of the population and targeting subsidies to those who need them most. To this end, Bogotá, where fares are set at close to cost recovery, has designed and implemented a pro-poor public transit subsidy scheme that leverages the country's experience with poverty targeting instruments and the gradual adoption of smartcards in its new public transit system. This chapter presented a critical analysis of the structured process adopted in Bogotá to achieve a level of fares that is close to "cost recovery", and the rationale, design, implementation and impact of Bogotá's pro-poor public transit subsidy.

In terms of tariff policy, the experience in Bogotá suggests that tariffs set at "cost recovery" should be stripped down to the operating essentials, so as not to have the users pay for capital cost or societal benefits. Furthermore, it becomes increasingly important, particularly after the initial stages of the reform, that each element or service competent included in the tariff is openly tendered to ensure efficiency. Tariffs set at "cost recovery" levels are critical in many parts of the world, either for reasons of law or because money from the public coffers is not available. Hence, to deal with political pressures, it is recommended that (i) there is some assurance of cost efficiency; (ii) there are schemes in place, such as targeted subsidies, to deal with the poor; and (iii) high quality demand forecasts are done, to aim for realistic system equilibrium. Furthermore, as there are steep learning curves in the initial years of the reforms, it becomes critical that contractual terms are not unreasonably long, so that subsequent phases can incorporate the lessons learnt.

In terms of targeted demand subsidies in public transit, the case of Bogotá allows us to begin to understand how to design targeted subsidies so that the poor and most vulnerable are able to seize the economic, educational, health, and cultural opportunities that greater mobility provides. However, further research on this topic, including analysing the impacts on mobility patterns and quality of life of the target population is needed. A randomized impact evaluation is being considered in Bogotá to assess the impact of different subsidy schemes (increasing the percentage of the fare being subsidized, changing the number of trips, etc). A randomized trial will allow us to have further understanding of labour outcomes, mobility patterns and design optimal subsidies for the future.

Furthermore, the case of Bogotá also demonstrates that there might be other binding constraints to improving mobility for the urban poor. While the pro-poor subsidy in Bogotá focuses primarily on tackling increased affordability, other constraints such as the location of housing and employment opportunities matter, issues concerning an individual's employment accessibility. This dimension should also be integrated in further research in order to more fully understand the impact of transport demand-side subsidies.

Note

[1] This section is largely based on World Bank (2013), and Mehndiratta et al (2014).

References

Altshuler, A., Womack, J. and Pucher, J. (1981), "The Urban Transportation System: Politics and Policy Innovation", MIT Press, Cambridge, MA.

Departamento Nacional de Planeacion (DNP) (2015), SISBEN III, Background and Methodology.

Dodgson, J.S. (1987), "Benefits of Changes in Urban Public Transport Subsidies in the Major Australian Cities", *Transport Subsidy*, *Policy Journals*, Newbury.

Glaister, S. (1972), "The Economic Assessment of Local Transport Subsidies in Large".

Glaister, S. (1987), "Allocation of Urban Public Transport Subsidy", *Policy Journals*, Newbury.

Goldman, T., Corbett, S.and Wachs, M. (2001), "Local Option Transportation Taxes in the United States", Research Report UCB-ITS-RR-2001-3, University of California at Berkeley.

Grayling, T. (2001), "Cities', in Any More Fares? Delivering Better Bus Services", Institute for Public Policy Research, London.

Guataquí, Garcia and Rodriguez (2011), "Structural determinants of trade union membership in Colombia", *Perfil de Coyuntura Económica* Vol 17.

Gwilliam, K. (2012), "Practical Indicators for Comparing and Evaluating Subsidy Instruments", World Bank Paper.

Hamer, A. (1976), "The Selling of Rail rapid Transit", Lexington-Heath Books, Lexington, MA.

Hilton, G.W. (1974), "Federal Transit Subsidies", American Enterprise Institute, Washington DC.

Mehndiratta, S.R., Rodríguez, C. and Ochoa, C. (2014), "Targeted Subsidies in Public Transport: Combining Affordability with Financial Sustainability", World Bank.

Meyer, J. and Gomez Ibanez, L. (1981), "Autos, Transit and Cities", Harvard University Press.

Mohring, H. 1972, 'Optimization and Scale Economies in Urban Bus Transportation', *American Economic Review*, 62, pp.591-604.

Obeng, K. (2012), "The deadweight costs of operating and capital subsidies", *Journal of the Transportation Research Forum*,Vol. 49, No. 1.

Parry, I.W.H., and Small, K.A. (2009), "Should Urban Transit Subsidies be Reduced?", *American Economic Review*, 99, pp.700-24.

Pucher, J. (1983), "Who benefits from transit subsidies? Recent evidence from six metropolitan areas", Transportation Research Part A: General

Pucher, J., Markstedt, A. and Hirschman I. (1983), "Impact of Subsidies on the Costs of Urban Public Transport", *Journal of Transport Economics and Policy*.

Rodriguez, C., Gallego, J., Martínez, D., Montoya, S. and Peralta, T. (2016), "Examining the implementation and labor market outcomes of targeted transit subsidies: SISBEN Subsidy for Bogota's Urban Poor. Transportation Research Record.

Rodriguez, C., and Mehndiratta, S. (2014), "Bus Concession Contracts and Tariff Policy: Lessons from the Bogotá and Colombia Experience" http://docs.trb.org/prp/152951.pdf

Savage, I. (2008), "The Dynamics of Fare and Frequency Choice in Urban Transit", Mimeo, Northwestern University.

Savage, I. and Schupp, A. (1997), "Evaluating transit subsidies in Chicago", *Journal of Public Transportation* 1(2). pp.93-117.

Serebrisky, T., Gomez-Lobo, A., Estupinan, N. and Munoz-Raskin, R. (2009), "Affordability and Subsidies in Public Transport: What do we mean? What can be done?", *Transport Reviews*, 29(6), 2009, pp.715-739.

Small, K.A., and Gómez-Ibáñez, J. (2008), "Urban Transportation", in Cheshire, P. and E.S. Mills *Handbook of Regional and Urban Economics*, Volume 3, North-Holland, Amsterdam.

Train, K. (1977), "Transit Prices under Increasing Returns to Scale and a Loss Constraint", *Journal of Transport Economics and Policy*, Vol.XI No.2. pp.185-194.

Van Reeven, P. (2008), "Subsidization of Urban Public Transport and the Mohring Effect", *Journal of Transport Economics and Policy*, 42, 349-59.

Webber, M. (1976), "The BART Experience: What have we learned?", *The Public Interest*, Vol. 45, fall, pp 79-108.

World Bank (2002), "Colombia Poverty Report", *PREM, Latin America and Carribean Region*. Volume 1 No. 24524-CO.

World Bank (2005), Targeting Social Spending to the Poor with Proxy–Means Testing: Colombia's SISBEN System; Castaneda, T.

World Bank (2009), *Building a Targeting System for Bangladesh based on Proxy Means Testing*, Sharif, I.

World Bank (2011), *Project Performance Assessment - Colombia Social Safety Net Project*.

World Bank (2012), "Project Appraisal Document for the Support to the National Urban Transport Program Project".

World Bank (2013), *Design of a Targeted Public Transport Subsidy Scheme for Urban Transport Projects in Colombian Cities*, Report No. AUS5774.

Chapter 7
Is congestion pricing fair? Consumer and citizen perspectives on equity effects

Jonas Eliasson
Department for Transport Science, KTH Royal Institute of Technology
Stockholm, Sweden

This chapter discusses and analyses whether congestion charges can be considered to be "fair" in different senses to the word. Two different perspectives are distinguished: the consumer perspective and the citizen perspective. The consumer perspective is the traditional one in equity analyses, and includes changes in travel costs, travel times and so on. Using data from four European cities, the analysis shows that high-income groups pay more than low-income groups, but low-income groups pay a higher share of their income. This chapter argues that which distributional measure is most appropriate depends on the purpose(s) of the charging system. The citizen perspective is about individuals' view of social issues such as equity, procedural fairness and environmental issues. An individual can be viewed as a "winner" from a citizen perspective if a reform (such as congestion pricing) is aligned with his/her views of what is socially desirable. Using the same data set, the analysis presented shows to what extent different income groups "win" or "lose" from a citizen perspective – i.e., to what extent congestion pricing is aligned with the societal preferences of high- and low-income groups.

Introduction

Most transport economists and urban planners would agree that scarce road capacity should be priced, and would hence support congestion pricing as a way to decrease traffic jams and use scarce urban land more efficiently. There is also substantial evidence from several cities that congestion pricing indeed works as intended, and that the aggregate social benefits can by far exceed investment and operating costs, provided that the system is well designed.

However, perhaps the most pervasive argument against congestion pricing is that it is unfair – a statement that can be interpreted in several different ways. The purpose of this chapter is to discuss and analyse to what extent congestion pricing is "fair", in several different senses of the word. The quantitative analyses use survey data from four European cities: Stockholm and Gothenburg (Sweden), Helsinki (Finland) and Lyon (France). Stockholm and Gothenburg have operational congestion charging systems, whereas Helsinki and Lyon do not. In the survey, respondents answered a range of questions regarding their travel behaviour, their views of fairness and several societal/political questions, and how they would vote in a hypothetical referendum about congestion pricing.

The purpose is to explore the fairness of congestion pricing from two perspectives, which can be called the consumer and citizen perspectives[1] (Nyborg, 2000; Sagoff, 1988). The consumer perspective includes how an individual is affected personally: how much tolls he pays, how much travel time he saves, his valuation of travel time and (if specified) the benefit of the recycled revenues. The citizen perspective is about what the individual sees as "fair", "just" or "desirable" from a social perspective, disregarding his own self-interest. Clearly, these two perspectives are affected by each other. What an individual thinks is "fair" is often correlated with what will benefit himself – after all, (all) humans are not saints, at least not on the subconscious level. But just as clearly, opinions about societal issues are not only determined by self-interest. There is abundant evidence that people's votes and behaviour are also affected by other concerns than self-interest, for example concerns about equity, environment and procedural fairness.

Hence, congestion pricing may be seen as "unfair" in two senses, or both. First, they may be seen as unfair in a "consumer" perspective, if they hurt low income groups disproportionately: if the poor pay more in tolls than the rich, if they value their times savings less, or if they get less benefit from the revenues. Effects can either be measured in absolute terms or proportional to income; we will argue that which is the most appropriate measure depends on to what extent the charges are (also) a fiscal policy. The consumer perspective – tolls paid, time gained and revenue recycling – is the traditional perspective on fairness in equity analyses of congestion charges, and there is abundant literature (e.g. Eliasson & Mattsson, 2006; Karlström & Franklin, 2009; Levinson, 2010; Small, 1992). This perspective is analysed and discussed in the first part of the chapter. Comparing results from the four cities show some striking similarities, despite different system designs and travel patterns.

Second, congestion charges may be seen as unfair from a "citizen" perspective. This would be the case if the support (or acceptability) of the fundamental underlying rationality or justification of congestion pricing differs across socioeconomic groups. For example, imagine a scarce resource which can be allocated through three alternative mechanisms: pricing, queuing or by some administrative/bureaucratic decision. Different individuals obviously prefer different mechanisms, for a variety of reasons, and the same individual may prefer different mechanisms in different contexts. Say that an individual can be labelled a "winner", from a citizen point of view, when her preferred allocation mechanism is the one that is used. Similarly, citizens can be labelled "winners" when societal decisions regarding, say, environmental regulations or tax progressivity are made in consistency with their preferences as citizens (which may or may not be aligned with their "consumer" interests). The question is now whether the share of "winners" on congestion pricing is different across (socio-)economic groups. This would be the case if congestion pricing is an "elite" project, which is more consistent with richer and/or more educated groups' views of what is fair, just or socially desirable. It is known from previous research that, ceteris paribus, support for congestion pricing is higher among individuals who rate environmental issues as important, and who perceive pricing as a fair allocation instrument. It is easy to imagine that high-income groups may view pricing as a fairer allocation mechanism than, say, administrative decisions – perhaps due to education, or self-interest, or social norms. It is also conceivable that high-income groups may place a relatively higher weight on environmental benefits. Whatever the reason, if this is the case, it would be reasonable to conclude that rich groups are "winners" from a citizen perspective, whether or not they are winners from a consumer perspective. These questions are discussed and analysed in the second part of the chapter. Comparing results from the four cities again show striking similarities, despite different political cultures in general and framing of the congestion pricing issue in particular.

Background and data

The data in this study comes from a survey first designed by a Swedish-French-Finnish team of researchers, and carried out in Stockholm, Lyon and Helsinki in 2011 (Hamilton, Eliasson, Brundell-Freij, Raux, & Souche, 2014). Later, two waves of the survey (with some minor modifications) were carried out in Gothenburg in 2012 and 2013, i.e. both right before and almost one year after Gothenburg introduced its congestion pricing system (in January 2013) (Börjesson, Eliasson, & Hamilton, 2016). The references provide more information about the data and its collection. The survey was presented as a general survey about several transport-related issues; to avoid policy bias, it was deliberately not presented as a survey specifically about congestion charges.

All the four cities are medium-sized cities with fairly typical European structures and transport systems. All have a historical city centre encircled by more recently populated areas. Around 80% of households have access to at least one car. Trips have a predominantly radial pattern, with the main flow of commuters moving inward in the morning and outward in the evening. Public transport shares vary, but are much higher than e.g. typical US levels in all the four cities. Transit fares are subsidized around 50%. Stockholm and Gothenburg have operational congestion charging systems, whereas Helsinki and Lyon do not.

In the survey, respondents were asked how they would vote in a (hypothetical) referendum about congestion charges. Respondents were presented with different systems in the four cities. In Stockholm and Gothenburg, the question referred to the actual systems. The Stockholm system was introduced in 2006, and consists of a cordon around the inner city where drivers pay EUR 1 to EUR 2 per passage (both directions) during weekdays, depending on time of day between 06.30 and 18.30. (The Stockholm experiences are further described in e.g. Eliasson (2008) and Börjesson et. al. (2012).) The Gothenburg system, introduced in 2013, consists of a cordon with three additional charging borders located as rays out from the cordon. Drivers pay EUR 0.8 – 1.8 per passage (in both directions) depending on the time of day, weekdays 06:00-18:30. (Traffic effects are described in Börjesson and Kristoffersson (2015), and public attitudes in Börjesson, Eliasson and Hamilton (2016).)

In Helsinki, the question referred to a proposed system intensively debated at the time of the survey. The system was supposed to be based on GPS units in all vehicles, with different tariffs per kilometre in two zones – an inner zone covering the central area in Helsinki, and an outer zone covering most of Helsinki. Political support for congestion pricing was never widespread, and at the time of the survey, it became clear that there was a decisive majority against its implementation. At present, there are no plans for implementing congestion pricing in Helsinki.

In Lyon, the question referred to a hypothetical system where all cars entering the urban centre would pay EUR 3 per day, independent of time of day or day of the week, with a maximum of EUR 50 per month.

Table 7.1. **Description of the surveys**

	Stockholm	Helsinki	Lyon	Gothenburg, 2012	Gothenburg, 2013
Date	Spring 2011	Spring 2011	Spring 2011	December 2012	December 2013
Method	Postal	Postal	Telephone	Postal	Postal
Number of responses	1 837	1 178	1 500	1 582	1 426
Response rate	43%	39%	37%	40%	38%

The subsequent analyses are based on approximate monthly toll payments, calculated from respondents' own statements. In Stockholm, Lyon and Gothenburg, respondents were asked how often they paid the congestion charge (Stockholm and Gothenburg 2013) or would pay if they drove as today (Lyon and Gothenburg 2012), and this was converted into approximate monthly payments using data on the average payment per day. In the case of Helsinki, respondents were asked how many kilometres they drove in each zone on an average day, which was then also converted into an approximate monthly payment. Obviously, relying on respondents' own estimates of their toll payments introduces some uncertainty, so numerical results need to be treated with some caution. However, the general patterns in the results are robust enough that this is not a significant problem for the purposes of this chapter.

Consumer perspectives on the fairness of congestion pricing

The standard economic welfare effects of congestion charges are made up of four parts: paid tolls, adaptation costs (adjusting one's travel pattern to the charges), the value of travel time gains and finally the benefit of the recycled revenues. In the first section, we will concentrate only on the equity effects of the paid tolls. This is admittedly only a partial analysis, but nonetheless a relevant one. Regarding adaptation costs, they generally make up a small part of the total welfare effect[2]. The value of travel time gains may be substantial, but unfortunately they are difficult to quantify based on our survey data; however, an attempt is made in the next subsection. Fortunately, previous research has shown that the amount of tolls paid is a good proxy for the total welfare effect, including adaptation costs and travel time benefits (Eliasson & Levander, 2006; Eliasson & Mattsson, 2006). The use of revenues, finally, is of absolutely crucial importance for the equity effects of congestion charging reform seen as a whole. However, how revenues are used can be seen as a separate issue, and it is illustrative to analyse the direct equity effects of congestion charges separately from the equity effects of the revenue use.

Hence, the first subsection analyses the incidence of toll payments across income groups in the four cities. In the second subsection, more variables relating to self-interest are introduced: the value of travel time savings, the number of car trips and the number of cars in the household.

Incidence of toll payments across income groups

Distributional profile of toll payments

The four systems differ considerably in their design, and in particular with respect to how much people [would] pay in tolls on average. Figure 7.1 shows how many who [would] pay different amounts in tolls, as a share of the region's population. In Stockholm, the share of the population who pay high amounts in tolls is low, whereas in the suggested Helsinki and Lyon systems, large shares of the population would pay rather substantial amounts. The results from the Gothenburg system are interesting compared to Stockholm: although the charge per passage is lower than in Stockholm, the Gothenburg system affects a much larger share of the population, which makes the share of the population who pay high amounts much larger than in Stockholm.

Figure 7.1. **Share of population who pay various amounts in tolls**

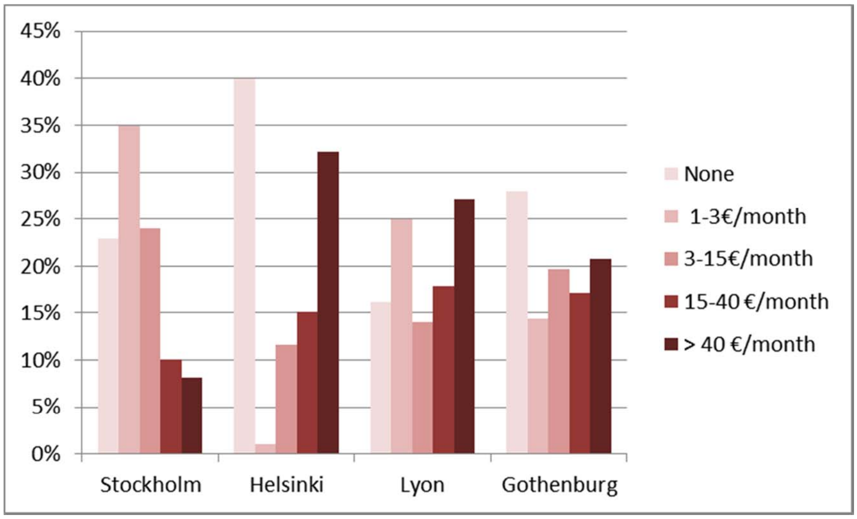
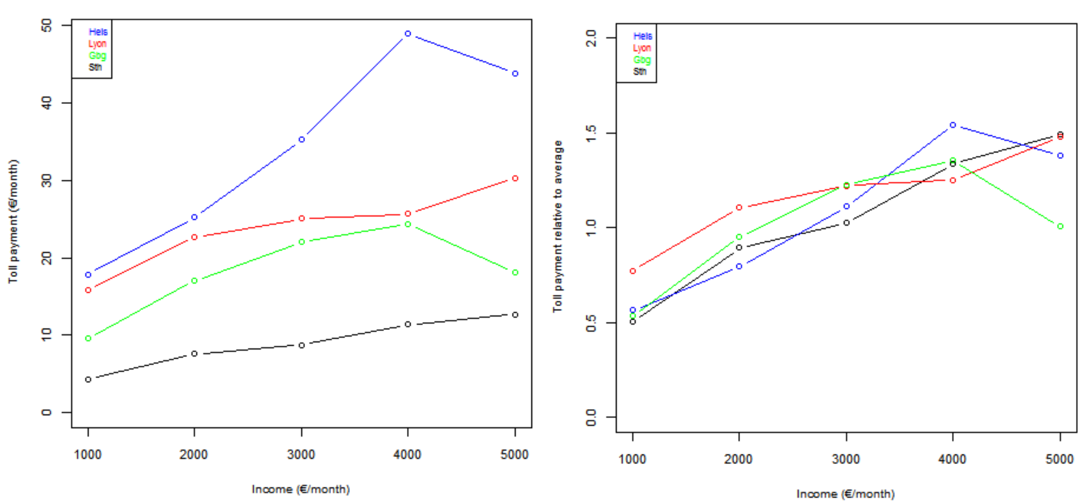


Figure 7.2 shows average toll payments per income group in the four cities. The left pane shows results in absolute numbers, while the right pane shows the results normalised by the average toll payment in each city, to facilitate comparison between cities.

Figure 7.2. **Average toll payments per income class**

Absolute numbers (left) and relative to average toll payment (right)

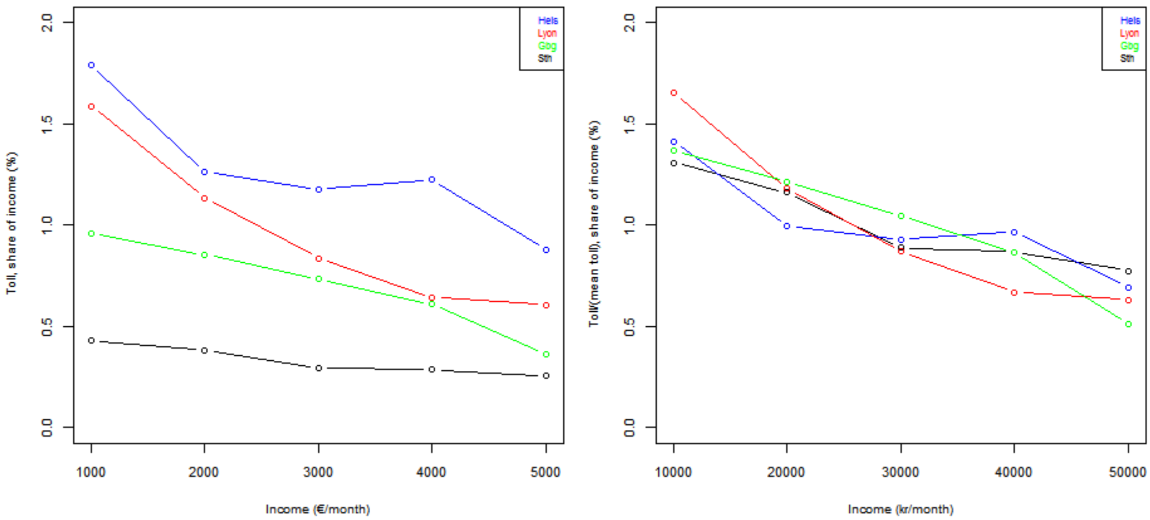


In all cities, high income groups pay much more than low income groups. Looking at the right pane, the differences across income groups are surprisingly similar in the four cities, despite the differences in system design and socioeconomic geography. In Gothenburg and Helsinki, however, the highest income group pay less than the middle groups. In Helsinki it is because the highest income group tend to live and work more centrally, and hence drive shorter distances on average. In Gothenburg, it is because company cars are exempt from congestion charges (according to Swedish tax law), and high income groups have access to company cars to a much larger extent. The company car exemption is discussed further below.

However, even if the poor pay less than the rich, they actually pay more relative to their income, as shown in Figure 7.3. The left pane shows average toll payments as a share of income[3] for each income class, while the right pane shows the same thing but normalised to allow comparisons across cities.

Figure 7.3. **Average toll payments as share of income, per income class**

Percentages (left), relative to average percentage (right)



The figures reveal that the congestion charges are in fact regressive in all the cities – total payments relative to income falls with increasing income. The diagrams indicate that the regressivity seems to be largest in Lyon and smallest in Stockholm. A common measure of the overall regressivity of a tax instrument is the Suits index (Suits, 1977). A flat-rate tax has Suits index 0, a regressive tax has a negative Suits index and a progressive tax a positive index. The index is bounded between -1 and 1. Table 7.2 shows the Suits indices for the four systems.

Table 7.2. **Suits index (overall regressivity/progressivity) of the congestion charges**

City	Suits index
Stockholm	-0.09
Helsinki	-0.09
Lyon	-0.16
Gothenburg	-0.13

That congestion pricing is regressive in this sense is actually an expected result: a consumption tax will be regressive if the consumption elasticity with respect to income is lower than 1. Even if driving (especially in the urban centres) increases with income, it usually increases less than proportionally to income, which means that most taxes on car driving will be (at least slightly) regressive. The Suits indices in Table 7.2 reveal that the analysed systems in Stockholm and Helsinki are slightly regressive, while the Lyon and Gothenburg systems are moderately regressive. For comparison, Metcalf (1996) calculates the Suits index of the US sales tax to -0.11; CPPP (2007) calculates Suits indices of the gas tax and sales tax in Texas to -0.25 and -0.18, respectively; West (2004) calculate Suits indices of a US VMT tax and a size-differentiated vehicle tax to 0.14 and -0.30, respectively; Eliasson et al. (2016) calculate Suits indices of the Swedish fuel tax and a differentiated vehicle tax to 0.03 and ¬ 0.09, respectively.

Are the distributional profiles fair?

What, then, is the most appropriate definition of "fairness"? Is congestion pricing fair as long as the rich pay more than the poor? Or is it fair only when the poor pay a lower share of their income? This is a question without a clear answer, but a few things can be pointed out.

First, prices are usually the same for everyone, regardless of income or wealth (with the exception of a few deliberate exceptions such as subsidized healthcare and social housing). Prices of gasoline, cars, food, clothes, housing and so on do not vary with income[4]. The social desire for increased equality is instead usually handled by taxation and welfare systems. The fundamental reasons for redistributing income rather than letting prices depend on income are two: first, the government can then leave to each individual to choose how she wants to allocate her income on various goods, according to her own preferences; second, the price of each good will reflect its "value" in terms of scarcity and/or production cost, so having the same price for everyone will achieve a Pareto efficient outcome. Now, the purpose of a congestion charge is to correct the price of car driving for external effects, to make it better reflect the total social cost of car driving. In other words, the price for car driving with the congestion charge is what the price really should be; without the charge, driving is subsidised from a social point of view. From this perspective, it can in fact be argued that the distributional effects of introducing congestion pricing are irrelevant – that is, if one accepts that the default situation is that prices are equal for everyone, and should reflect the true, social cost for each good. At least, one should realize that arguing against corrective taxes with distributional arguments is logically equivalent to arguing that the good in question (car travel, for example) should be subsidized for distributional reasons – and this is often a much less persuasive or intuitively appealing argument.

Second, however, congestion charges may well have a strong fiscal motivation as well. The Gothenburg system is a good illustration: the system was designed to generate revenue of at least 1 billion kronor (EUR 100 million) per year to be used for infrastructure investments. As a secondary purpose, the system should decrease congestion as efficiently as possible, given this revenue constraint. In such cases, congestion pricing is clearly not only about correcting prices; the purpose is at least as much to generate public revenues. This makes it more appropriate to compare distributional effects of charges against income taxation; had the revenues not come from congestion charges, they would have had to come from the usual public tax sources. Hence, comparing toll payments relative to income is a natural default position in such cases.

Third, being aware of the distributional effects of any new policy is clearly important. Any change in prices causes transition costs which may be important to consider, at least for determining at which speed a change can be implemented. Moreover, real congestion pricing systems are not perfect – they do not, in reality, perfectly reflect the true social cost of each car trip due to technical or cognitive constraints; some car trips will actually be overpriced, while others will still be underpriced. In this perspective, it can be relevant to check how many drivers experience a substantial increase in travel costs, defining "substantial" in some suitable way. If this share is high, especially in low-income groups, it may be a warning signal indicating either that the policy may be too ambitious too fast, or that the design punishes some trips disproportionately.

Looking only at averages hides the fact that the variation within each income group may be substantial. Compare this to an income tax, which will by definition affect everyone with the same income in the same way. In the case of congestion charges, there may be subgroups who are hurt disproportionately relative to their income, even if the charge is progressive overall (or at least not very regressive). This is in fact often the most important argument of those arguing against congestion charges using distributional arguments: not that the policy is necessarily very regressive on average, but that there may be non-negligible subgroups who are hurt disproportionately.

With this in mind, Table 7.3 shows the share of each income group who [would] pay more than EUR 40 /month in congestion charges. In Stockholm and Gothenburg, the shares are (very) small in the lower income groups, although they may still be non-negligible of course. In the suggested Lyon and Helsinki systems, however, the shares are quite high even in the lowest income groups, meaning that there are quite a few people who would see their driving costs rise considerably even among the poor. Remember, though, that these systems were never properly evaluated and re-designed. The Helsinki system was a real suggestion, but never made it further than the initial political debate. The Lyon system was designed for the purpose of the survey. Hence, it seems that real congestion pricing systems can be designed to have a much smaller impact on travel costs.

Table 7.3. **Share of each income class who [would] pay more than EUR 40/month in congestion charges**

€/month	1000	2000	3000	4000	5000
Stockholm	2%	7%	7%	13%	15%
Helsinki	15%	26%	35%	53%	47%
Lyon	18%	31%	36%	37%	48%
Gothenburg	7%	18%	29%	32%	22%

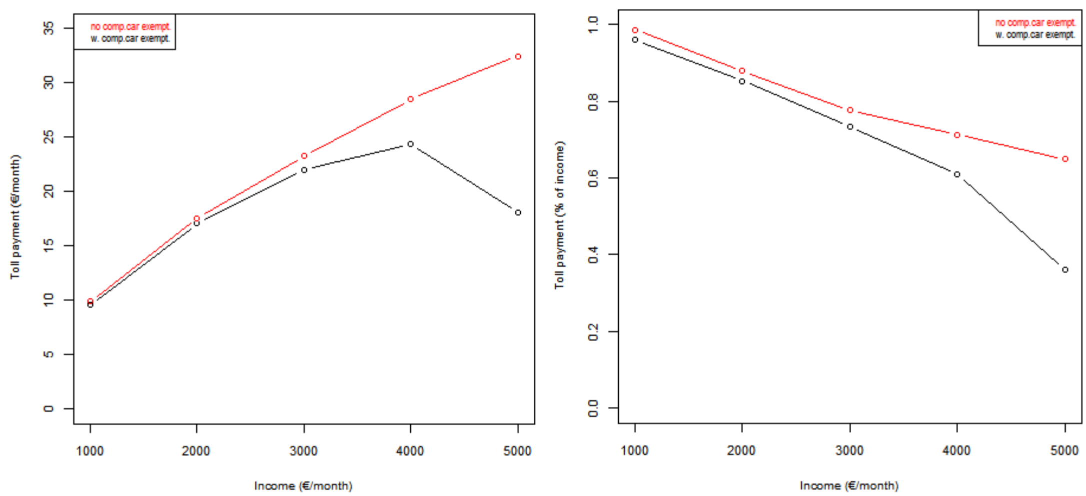
Lessons from the Swedish company car exemption

The Swedish company car exemption is an example of a generally important point, namely that the distributional effects of congestion charges depends on the specific design of the charging system, and that legal decisions may have unintended consequences. Some time after congestion charges had been introduced in Stockholm, the tax court determined that congestion charges were to be considered part of the operating costs of the car, and as such they were included in the "taxable benefit value" of a company car. This meant that company car owners either paid no charge at all, or could deduct the charge from their before-tax salary (which implied a substantial discount), depending on the company's policy. This was a completely unintended consequence of how the tax law interacted with the legal definition of the congestion charge (which, in legal terms, is a national tax) – but it had substantial effects on the distributional profile of the charges, especially in Gothenburg with its high prevalence of company cars in high income groups (the city is dominated by the car industry).

Figure 7.4 shows the effect of the exemption. Without it, the highest income group had paid the most; with it, the richest group pay on average as little as the second-lowest income group. Further, the regressivity had been much smaller without the exemption: the Suits index had been 0.06 rather than 0.13. The effect in Stockholm seems to be smaller, but unfortunately, there is so far no data available for Stockholm to analyse this in depth.

Figure 7.4. **Average toll payments per income group, with company car exemption (black) and without (red)**

Absolute numbers (left) and as share of income (right)



Tax rules for company cars are complicated in many countries, and the design of these rules may have profound and substantial effects on travel patterns and equity (see for example an analysis of a change in the UK tax rules by Le Vine et al. (2013)). As the Gothenburg example shows, it may drastically change the distributional profile of congestion pricing. More generally, the lesson is that exemptions of various kinds – for residents, professional traffic, certain residential areas and so on – may have important and perhaps unintended consequences both for the effectiveness and the distributional profile of congestion pricing.

Distributional effects in other dimensions

In addition to income, congestion pricing can have distributional effects across other socioeconomic characteristics as well. Perhaps surprisingly, these differences are relatively small once income is controlled for. Detailed results are omitted to save space. The main differences across socioeconomic groups (controlling for income) are:

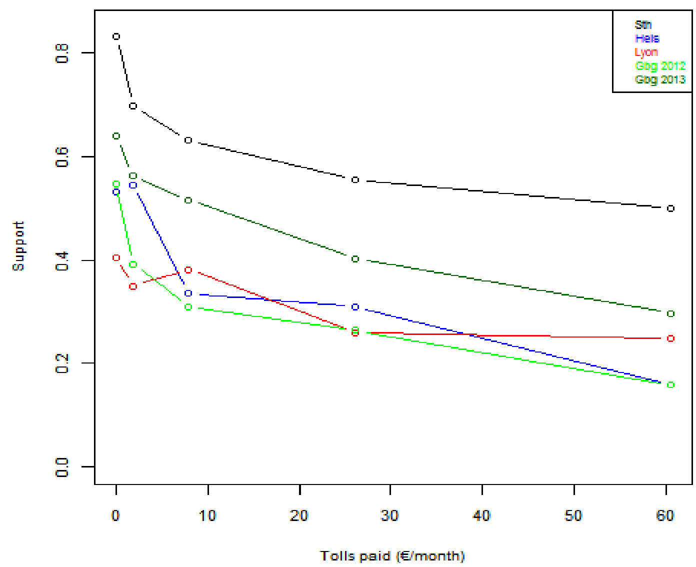
- In Lyon and Gothenburg, households with children under 18 years of age [would] pay more tolls (controlling for income) than households without children.
- In all cities except Gothenburg, men [would] pay more than women (even controlling for income differences). The difference is largest, in relative terms, for middle income groups.
- In Lyon, people older than 65 years would pay less (after controlling for income). In the other cities, differences across age groups are negligible.
- Education does not affect average toll payments in any systematic way.

Broadening the perspective: Incidence of compound self-interest

How much someone pays [would pay] affects the person's attitude to a suggested congestion pricing system: all else equal, people are more negative the more they [would] pay (e.g. Börjesson et al., 2016; Eliasson, 2014; Eliasson & Jonsson, 2011; Gaunt, Rye, & Allen, 2007; Hamilton et al., 2014; Hårsman & Quigley, 2010; Jaensirisak, May, & Wardman, 2003; Schade & Schlag, 2003). Respondents were asked how they would vote in a referendum about congestion pricing, regarding the actual schemes in Stockholm and Gothenburg, the debated scheme in Helsinki, and a hypothetical area charging scheme in

Lyon. The response alternatives were "Certainly yes", "Probably yes", "Probably no", "Certainly no" or "No opinion/I don't know". Answers clearly correlated with the amount of tolls respondents paid or would pay. Defining "support" as the share of positive responses excluding "No opinion/I don't know", Figure 7.5 illustrates how support depends on the [anticipated] toll payments.

Figure 7.5. **Support for congestion pricing with respect to toll payments (EUR/month)**



Clearly, support falls as toll payments increase. Note, however, that the biggest drop in support is between those who pay no toll at all (e.g. don't own a car) and those who pay something, albeit just a little (Lyon is an exception). It is interesting how similar the patterns are in the three cities without congestion charges: Helsinki, Lyon and Gothenburg in 2012 (before the system started). The figure also illustrates the "experience" effect in Gothenburg: the Gothenburg 2013 curve has moved upwards with almost precisely the same shift for all groups, regardless of toll payments (although the effect is slightly smaller for those who pay no toll at all).

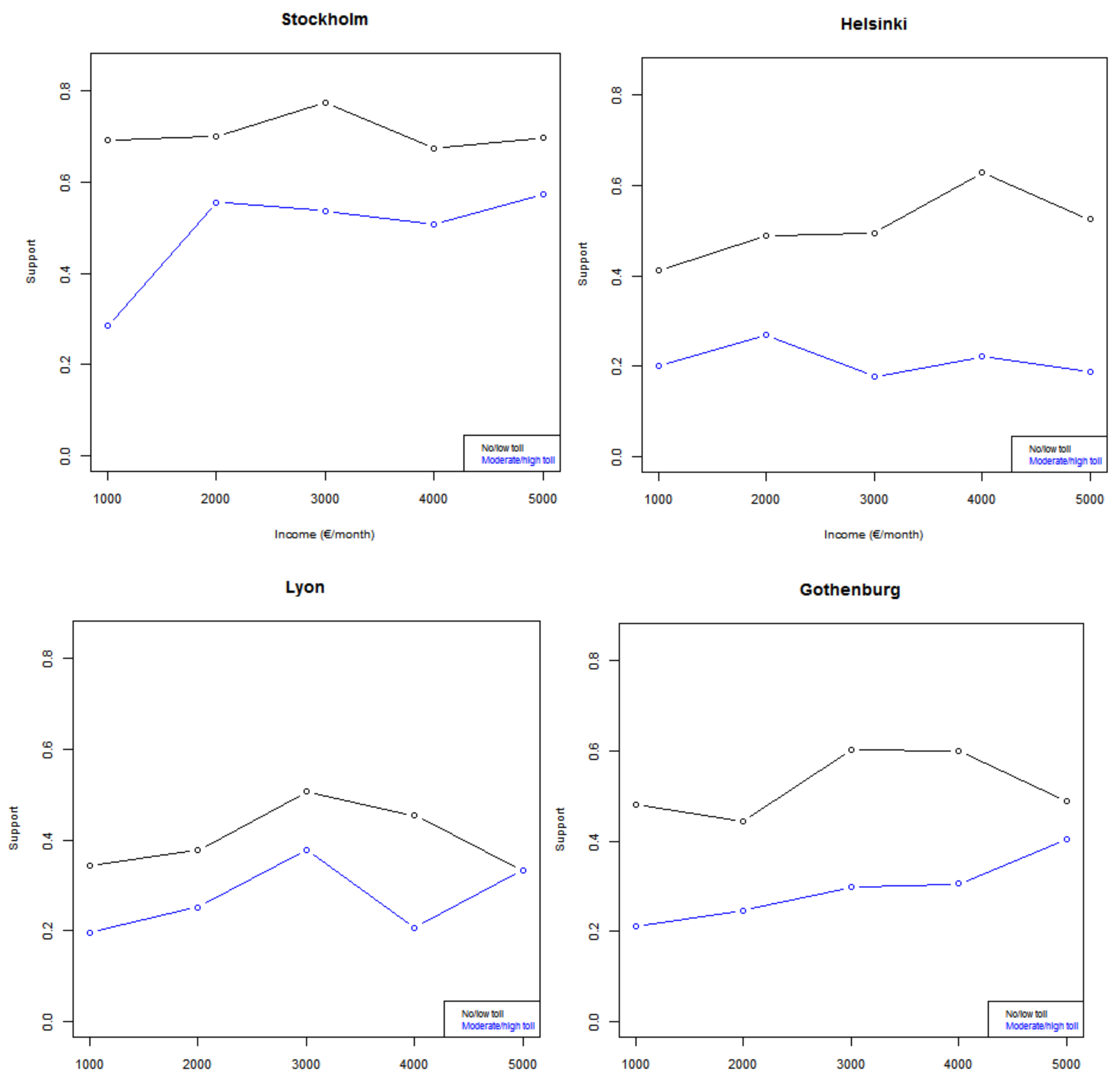
In addition to toll payments, attitudes are also affected (as we shall see) by several other variables which are related to self-interest, and should hence be included in the consumer perspective: how many car trips a respondent makes, her value of travel time savings and how many cars there are in the household. That the number of cars and car trips significantly affect attitudes to congestion pricing even after controlling for toll payments may be for several reasons: it may reflect the general car dependency of the household or individual, for example.

The fact that there are more variables than just toll payments which affect attitudes to congestion pricing means that an analysis which only takes toll payments into account may not fully reflect the subjective benefits and losses of charges, as perceived by the individual. If the aim is to measure the incidence of congestion pricing as perceived by the individuals themselves, the analysis has to be extended to account for these other variables as well. After all, these variables also reflect various aspects of the perceived personal incidence of the congestion charges. I will call this total, perceived, personal incidence the compound self-interest, since it is the sum of several factors: tolls paid, time gains, adaptation costs and so on.

How, then, should these variables be weighted together? A natural approach is to estimate a statistical model of how they affect respondents' attitude to congestion charges, and take the estimated model parameters as relative weights of the different variables. In this way, the variables act as indicators of or proxies for different aspects in which congestion charges affect the individuals, which in turn allows for a richer analysis of the distributional effect of congestion pricing.

In addition, it is desirable to take into account that variables may affect different income groups differently. For example, it might be natural to expect that the same amount of toll payments might cause more disutility for low income groups than for high income groups, simply because low income groups might have higher marginal utility of income. Exploring the data, however, gives only limited support for this hypothesis. Figure 7.6 shows that there are only a few cases where it seems as if (high) toll payments affect attitudes differently across income groups.

Figure 7.6. **Support for congestion pricing in different income groups, split by those who pay little or nothing (black) and those who pay moderate or large amounts (blue)**



Cross-tabulations of this kind only give rough indications, of course. To properly separate the impact of different variables, respondents' attitude to congestion pricing (how they would vote in a referendum) is regressed on various self-interested-related variables. A potential problem with the model estimation is that attitudes are affected by several other variables as well – in particular other attitudes – and if we omit these, the parameter estimates may be biased if there are correlations between included and omitted variables. Fortunately, however, this turns out not to be a problem: when attitude variables are introduced in the model (see next section), this does not change the parameters for the self-interest variables appreciably. Moreover, the general conclusions are robust for various other model specifications.

Since the voting response is an ordered variable, an ordered logit model is used. A comprehensive description of ordered models can be found in Greene (2003), but a short intuitive description is necessary. Let y be a latent (unobservable) variable, which is a linear function of a vector of observable variables X, a parameter vector β (to be estimated) and an idiosyncratic term ε

$$y = \beta X + \varepsilon$$

The latent variable y can be interpreted as a measure of how positive an individual is to congestion charges, which cannot be observed (measured) directly. What is observable is the voting response z, which has five ordered levels z=1,…,5 from most negative to most positive. We assume that this response is determined by in which of five intervals y falls. The limits of the intervals are determined by estimated threshold parameters μ_k, so we have

$$z = 1 \text{ if } y \leq \mu_1$$
$$z = 2 \text{ if } \mu_1 \leq y \leq \mu_2$$
$$(\ldots)$$
$$z = 5 \text{ if } \mu_4 \leq y$$

Assuming that ε is logistically distributed, the probabilities that z=i become

$$P_1 = 1 - \frac{1}{1 + \exp(\mu_1 - \beta X)}$$

$$P_i = \frac{1}{1 + \exp(\mu_i - \beta X)} - \frac{1}{1 + \exp(\mu_{i-1} - \beta X)} \quad i \in \{2,3,4\}$$

$$P_5 = \frac{1}{1 + \exp(\mu_4 - \beta X)}$$

Table 7.4 shows the estimation results from the ordered logit model, indicating how respondents' attitude to congestion charges (as measured by the voting response) is affected by various self-interested-related variables. A large number of model specifications have been tested, but details are omitted to save space. Positive parameters indicate that support increases when the variable increases.

Table 7.4. **Estimation results: impact of self-interest variables on attitude to congestion pricing**

	Value	Std. Error	t value
Tolls	-0.0010832	0.0001125	-9.6249
Tolls, add. inc.grp 1	-0.0007957	0.0002209	-3.6030
No car	0.3061705	0.0610495	5.0151
Car trips	0.4306097	0.0284951	15.1117
Value of time, drivers	0.2389846	0.0189181	12.6326
Stockholm	0.9948645	0.0668150	14.8898
Helsinki	0.0213867	0.0740519	0.2888
Lyon	-0.1766564	0.0722816	-2.4440
Gothenburg2014	0.5572110	0.0697637	7.9871

Intercepts:

	Value	Std. Error	t value
1|2	0.4265	0.1022	4.1721
2|3	1.4528	0.1034	14.0502
3|4	1.9839	0.1047	18.9533
4|5	3.3649	0.1098	30.6583

Residual Deviance: 19960.01
AIC: 19986.01

Toll payments affect attitudes negatively; the effect is proportional to the amount of tolls paid. This effect is stronger for the lowest income group (<EUR 1 500/month) (the two “tolls” parameters are added), but there are in fact no significant differences among the other income groups. Not owning a car at all increases support more than can be explained merely by not having to pay tolls, so a dummy variable for “no car in household” is significant and positive. More car trips decrease support (with a linear effect), even after controlling for toll payments. The model also includes dummy variables for the different cities and for the difference in Gothenburg between 2012 and 2013; Gothenburg 2012 is taken as the reference level. The attitude differences between Gothenburg 2012, Lyon and Helsinki (neither of which had congestion pricing in place) are very small, while attitudes in Stockholm and Gothenburg 2013 (after congestion pricing was introduced) are much more positive.

Finally, the value of travel time savings has a substantial positive impact on support for those who make at least a few car trips per week. The value of travel time savings was measured with the following thought experiment:

You commute daily by car. On the way, you have to cross a bridge[5] across a river. One day, the bridge closes for repairs for a long time. Another bridge is available further downstream, but the detour takes an additional 20 minutes. During the time it takes to repair the bridge, the road authority has arranged with a ferry that can take cars over the river. What is the highest amount you would be prepared to pay for a one-way ticket for the ferry, to save 20 minutes on your journey to work?

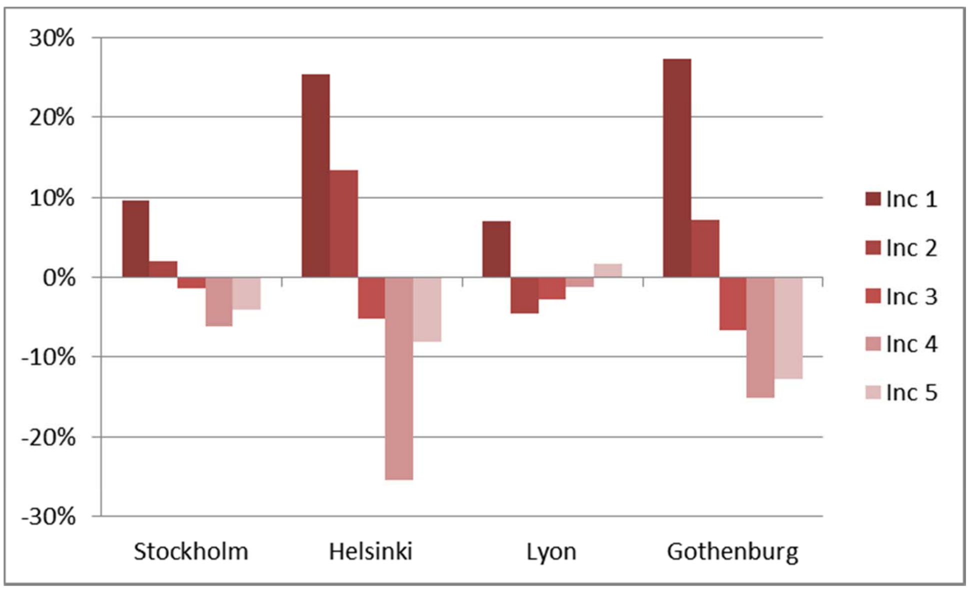
Respondents were given seven alternative answers ranging from “nothing” to “more than EUR 5”.

For our purposes, it is important to note that the impacts of the self-interest-related variables do not vary systematically across income groups (except for toll payments in the lowest income group). Surprisingly, the effect on attitudes of making one car trip more or paying one more euro in tolls and so on seems to be the same, regardless of income. A plausible hypothesis is that for the moderate monetary amounts we are considering, the differences in marginal utility of money are not large enough to matter for attitudes.

With the model results in hand, we can calculate a broader measure of the perceived incidence of congestion charges across income groups, simply by calculating the relative differences in the latent variable y across income groups. Note that this is an exploratory analysis where the numerical results must be interpreted with caution: there is no guarantee that y can be interpreted cardinally, or in other words, that the absolute magnitude of y is meaningful (since the “unit” of y may not be constant if the distances between thresholds are very different). However, comparing average values of y across income groups will give an indication whether some income groups can be said to be worse off[6].

Figure 7.7 shows the distributional profile across income groups for the four cities. Results have been normalized for each city, since the purpose is just to compare the relative tendency across income groups for each city. (Let y_n be the latent variable for individual n. The bar in the histogram corresponding to income group i in city j is $B_j^i = \frac{\sum_{n\in(i,j)} y_n}{\sum_{n\in j} y_n} - 1$. In other words, the diagram shows how much better or worse off each income group of a city is, on average, compared to the average citizen in that city. (Remember that this measures only "self-interest" effects, weighted as individuals perceive the effects themselves, as measured by their voting response.)

Figure 7.7. **Average compound self-interest per income group, relative to the mean in each city**



Except for Lyon, the pattern is the same in all cities: higher income groups are worse off, but the highest income group is in fact a little better off than the second-highest. This is partly due to this group having high values of time (on average), and partly due to average toll payments being lower than for the second-highest group due to central residential locations (Helsinki) or company car exemptions (Stockholm and Gothenburg). The relative differences across income groups are smaller in Stockholm than in Gothenburg and Helsinki. For Lyon, the distributional profile of the suggested system is different: the lowest income group is better off than the average, but after that, higher income groups are better off than lower income groups. The primary reason for this seems to be the design of the (hypothetical) Lyon system, where all car trips in the entire urban area is charged the same amount, regardless of time of day, destination or distance.

Broadly speaking, this shows that congestion pricing is "progressive" (with a slight abuse of the term) in the sense that lower income groups are hurt less by direct self-interest effects – as perceived by the individuals themselves, as measured by how self-interest variables influence voting response. The exception is Lyon, but the reason for this seems to be the coarse design of the system: a more realistic and efficient design may well have yielded other results. The lesson that can be drawn from Lyon is, again, that the design of the system is crucial for the distributional profile.

Citizen perspectives on the fairness of congestion pricing

The previous section only dealt with fairness from a consumer perspective: how congestion pricing affects different income groups in terms of self-interest variables such as money, time and so on. This section analyses fairness from a citizen perspective. Different allocation mechanisms, and different social goals or benefits, can be viewed by citizens as "fair" in a more abstract sense. In this perspective, factors such as procedural justice, equity, equal treatments, human rights and the relative weights of different social objectives often matter (depending on the issue). Citizens' perceptions and definitions of fairness will vary, of course, and may well correlate with their self-interest – although the direction of causality is not always easy to establish – but this does not change the point that "fairness" is something that people apparently value in itself, even abstracting from their own self-interest.

Here, the analysis will focus on one particular issue, namely whether the opinions of congestion pricing from this citizen perspective vary systematically across socioeconomic groups – in particular across income groups. In other words, is the concept of congestion pricing – the principle of allocating scarce road space according to willingness to pay – more consistent with, say, high-income groups' views of what is "fair" or "just" than with low-income groups' views? If so, one could reasonably argue that congestion pricing is an "elite" project, since the concept would be better aligned with what high-income groups view as a "fair" or "just" society. A priori, there is no particular reason to expect neither this nor the opposite; but the issue clearly matters for the socio-ethical or democratic justification of congestion pricing, and the fact that we do not know what result to expect a priori makes the question interesting.

Disentangling this question, however, is complicated. Obviously, simply asking respondents "is congestion pricing fair?" will elicit responses so tainted with self-interest that it is virtually pointless. Instead, our survey contained a large number of questions about whether respondents perceived various allocation mechanisms as "fair", and also questions about other social issues such as environment and income equity. Through econometric modelling (controlling for self-interest variables), we can then reveal how perceptions of these more or less related issues correlate with the attitude to congestion pricing, and finally measure how well aligned congestion pricing is with these related socio-political views.

The question of how perceptions of fairness and other social issues vary across income groups and cities is of course interesting in itself. Therefore, the first subsection explores this, before the second subsection turns to our main issue of citizen perspectives of congestion pricing.

Opinions about fairness and related political issues

Respondents were presented with a number of statements, and asked to indicate to what extent they agreed on a 7-grade scale, from "completely disagree" (-3) over "neither agree nor disagree" (0) to "completely agree" (+3). Table 7.5 shows how respondents in the four cities agreed, on average, with the statements.

Table 7.5. **Average agreement (from -3 to 3) with statements**

		Stockholm	Helsinki	Lyon	Gothenburg
1	"Considerably more resources should be used to protect the natural environment."	1.4	1.3	2.1	1.3
2	"The government should prioritise to reduce the differences between the poor and the rich in the society."	0.9	1.2	1.7	1.3

3	”Taxes in [country] are too high”	0.8	1.2	1.3	0.3
4	Pricing the ferry is fair	1.9	1.4	0.3	0.9
5	Queuing to the ferry is fair	1.5	2.1	-1.2	0.8
6	Letting a public agency decide about space on the ferry is fair	0.1	-1.1	-1.6	-0.7
7	Giving out places on the ferry with a lottery is fair	-1.1	-1.3	-2.3	-2.2
8	“It is fair [justified] that airplane tickets cost more for departure during peak hours than during off-peak”	0.9	0.8	-0.4	0.3
9	“It is fair [justified] that airplane tickets to vacation destinations cost more when the weather in [country] is bad.”	-1.0	-1.2	n/a	-1.4
10	“It would be fair [justified] if transit fares were lower in off-peak hours”	1.0	0.6	0.7	0.9

Statements (1)-(3) are about general political issues: environment, social equity and taxes. Respondents broadly agree with the statements, on average. Almost no one disagrees with the environment statement (2). Swedish respondents agree less with the statement that taxes are too high (3). Comparing Stockholm and Gothenburg, more respondents in Gothenburg agree with the equity question (2) and disagree with the “taxes are high” question (3).

Statements (4)-(7) are perhaps the most interesting and relevant in the context of this chapter. Following the thought experiment about a ferry replacing the broken bridge (see above), respondents were given the following question:

Some people complain that it is unfair that the authority charges a price for the ferry tickets. When offering the ferry for free, it turns out that there is not room on the ferry for everyone who wants to use it. The authority now considers four different methods to choose who gets to travel with the ferry:

- *Price: Revert to the original policy of charging those who want to travel, and set the price so the ferry is just filled.*
- *Queue: Those who arrive first to the jetty and stand first in line get to go with the ferry.*
- *Authority determines “need”: Those who want to travel with the ferry have to show some evidence to support their need. The authority then provides ferry passes based on their judgment of the greatest need.*
- *Lottery: Tickets are allocated randomly, so that everybody has an equal chance of winning.*

To what extent do you consider these alternatives fair? [7 grade scale from “Completely unfair” (-3) to “Completely fair” (+3)]

In almost all cities, respondents rate the fairness similarly: pricing comes first, followed by queueing and then decisions by a public authority, with lottery as a distant fourth. Helsinki differs in that queueing is ranked as fairer than pricing. However, answers vary considerably across countries, and are actually in line with some clichés about national political cultures. French respondents rate all alternatives lower than respondents from other countries; in fact, 25% of French respondents rate all allocation mechanisms as more or less unfair (below 0) and 17% rate all allocation mechanisms as “very” or “completely” unfair (begging the question if there is any “fair” mechanism to allocate space on the ferry). Swedish respondents seem to put more trust in public authorities (which is consistent with many other studies), rating decisions by a public agency as fairer than respondents from other countries do.

Statements (8)-(10) concern various forms of scarcity pricing in other contexts. Differentiating air fares (8) and transit fares (10) with respect to peaks in demand is rated “fair” by a narrow majority of respondents in most cities – although in all cities, there are sizeable groups who rate this as unfair. However, commercial airlines taking advantage of increased demand due to bad weather strikes a majority of respondents as unfair. One interpretation is that there is a difference in perceived fairness of pricing between situations when supply is “necessarily” scarce – such as airport and transit capacity in peak hours – and situations where commercial companies simply extracts an increased willingness to pay.

For the purpose of this chapter, the most interesting question is whether the answers vary systematically with income – in particular, whether views of the fairness of allocation mechanisms (including pricing) do. Table 7.6 shows correlations between income and agreeing with the statements.

Table 7.6. **Correlation between income and agreement with the statement**

		Stockholm	Helsinki	Lyon	Gothenburg
1	“Considerably more resources should be used to protect the natural environment.”	-0.06	-0.10	-0.02	-0.04
2	“The government should prioritise to reduce the differences between the poor and the rich in the society.”	-0.19	-0.27	0.00	-0.17
3	”Taxes in [country] are too high”	0.06	-0.03	-0.01	0.02
4	Pricing the ferry is fair	0.00	0.01	0.01	0.02
5	Queueing to the ferry is fair	-0.08	-0.03	0.03	-0.05
6	Letting a public agency decide about space on the ferry is fair	0.02	0.01	-0.02	0.01
7	Giving out places on the ferry with a lottery is fair	-0.05	-0.02	0.01	-0.02
8	“It is fair[7] [justified] that airplane tickets cost more for departure during peak hours than during off-peak”	0.09	0.01	0.03	0.13
9	“It is fair [justified] that airplane tickets to vacation destinations cost more when the weather in [country] is bad.”	0.09	0.02	n/a	0.11
10	“It would be fair [justified] if transit fares were lower in off-peak hours”	0.00	-0.06	0.02	-0.03

The most striking result is that the correlation between agreement and income is generally very low. The main exception is only that low income groups agree much more with the equity question (2) (except in Lyon). Particularly surprising is the small differences across income groups in how respondents rate the fairness of pricing mechanisms (4,8,9,10) and whether taxes are too high (3). In Sweden, high-income groups have a slight tendency to agree more with air pricing questions (8,9) and that taxes are too high, but the tendency is small. More detailed analyses, also considering the tails and asymmetries of the distribution of answers, reveal a few more observations:

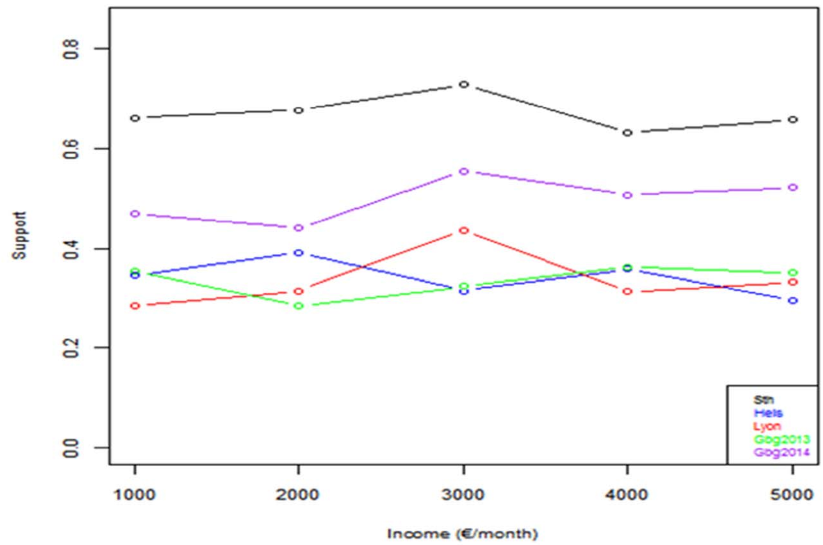
- Rich tend to agree more that having higher airfares in peak hours (8) is fair/justified. In particular, the share who agrees strongly with the statement is higher in rich groups.
- Rich tend to agree slightly more that it is fair/justified that airfares to vacation destination are higher when the weather is bad (9). In particular, the share who strongly disagrees is smaller among rich groups.
- In all cities except Helsinki, opinions about taxes (2) follows a U-shaped pattern: the two lowest income groups agree the most with that taxes are too high, but the highest income group agree more with this statement than the two middle income groups. In Helsinki, there is no correlation between income and opinions about taxes.
- Slightly fewer among the rich think that more resources should be spent on protecting the environment. In particular, fewer of the rich agree strongly; almost no one, in any income group, disagrees with the statement. In Stockholm and Gothenburg this tendency is small, whereas it is considerable in Lyon and Helsinki (the share who agree strongly (≥2) falls from 80% in the poorest group to 60% in the richest group in Lyon, and from 60% to 40% in Helsinki).
- Comparing which way to allocate space on the ferry is rated as the fairest by each individual reveals that a higher share of the rich rates pricing highest on the fairness scale. The difference is not big, however: in Stockholm, where this difference is largest, 50% in the richest group rate pricing as most fair, whereas 37% in the poorest group rate pricing as most fair.
- Conversely, slightly more in the poor groups rate allocating ferry space by a public authority as the most fair. More of the rich strongly disagree that this is a fair allocation mechanism. (There are no differences in how queueing is rated, however.)
- As already noted, a large share of French respondents rate all alternatives to allocate ferry space as unfair (in the other countries, this share is negligible – less than 2% of respondents). There is no difference across income groups in this respect.

Summing up these findings, a higher share of the poor agree with the equity statement (2), and a slightly higher share among the rich regard pricing as a fair allocation mechanism. On average, slightly fewer of the rich express strong environmental concerns (1). With these findings in hand, the next section explores correlation between these attitudes and the support for congestion pricing.

Citizen perspectives on congestion pricing

The main purpose of this section is to explore how “citizen” perspectives of congestion pricing vary across income groups, as explained above. An obvious place to start is to check whether the support for congestion pricing varies across income groups. As Figure 7.8 reveals, this is not the case: there is no particular systematic tendency in how different income groups would vote about congestion charges.

Figure 7.8. **Support for congestion charges across income groups in different cities (two different years in Gothenburg)**



However, these aggregate figures do not reveal enough, since voting responses are affected by a mixture of self-interest and other considerations. Instead, we estimate a revealing how the attitude to congestion pricing is affected both by self-interest variables and by a number of variables representing citizen perspectives. Since several of the attitude questions (Table 7.5) measure similar things (in particular the attitude to scarcity pricing in different contexts), a subset of these indicators has to be selected. After testing various options, the following variables are included in the model: environment (agreement rating of statement (1) in Table 7.5), equity (statement 2), taxes are too high (statement 3), pricing is fair (4) and agency decision is fair (6). All these variables can be expected to correlate with the attitude to congestion pricing. To what extent they do may depend on how congestion pricing is perceived or framed in the local public debate or discourse. For example, if congestion charges are perceived as "just another tax", then the correlation with the attitude to taxes can be expected to be strong; if congestion charging is perceived as an environmental policy, then the correlation with the attitude to environmental policy can be expected to be strong – and so on. Table 7.7 shows estimation results from the ordered logit model (a binary logit model distinguishing only positive/negative answers give similar results).

Table 7.7. **Variables affecting voting response (ordered logit)**

	Value	Std. Error	t value
Tolls	-0.0010111	0.0001179	-8.5742
Tolls, add. inc.grp 1	-0.0005993	0.0002281	-2.6274
No car	0.3297529	0.0641394	5.1412
cartrips	0.3327746	0.0302396	11.0046
Value of time, drivers	0.1825060	0.0199794	9.1347
Stockholm	1.0063928	0.0713684	14.1014
Helsinki	0.1555103	0.0780314	1.9929
Lyon	-0.0990411	0.0771785	-1.2833
Gothenburg2014	0.5615992	0.0776810	7.2296
environ	0.2609645	0.0166537	15.6701
TaxTooHigh	-0.2524060	0.0118604	-21.2813
PricingIsFair	0.1172166	0.0114416	10.2447
AgencyIsFair	0.0504215	0.0098760	5.1054
equity	-0.0042233	0.0134644	-0.3137

Intercepts:

	Value	Std. Error	t value
1|2	1.0315	0.1610	6.4059
2|3	2.1687	0.1627	13.3295
3|4	2.7289	0.1639	16.6526
4|5	4.2695	0.1684	25.3584

Residual Deviance: 17698.47
AIC: 17734.47

The parameters of the self-interest variables are broadly unchanged by the introduction of attitude variables. The first four are highly significant: environment and pricing is fair is associated with more positive attitudes, while taxes are too high is associated with a more negative attitude. Authority decision is fair is also associated with more positive attitudes, although this effect is smaller. At first this may seem counterintuitive: after all, approving of authority decisions based on subjective “need” may seem like the opposite to approving of market-based solutions based on willingness to pay. However, what this question measures is rather the trust in government – whether the respondent believes that public agencies are, on average, trustworthy. Previous research has shown that support for congestion pricing correlates with trust in government and also supporting various kinds of public interventions (e.g. speed cameras).

Two negative findings in the model estimation are interesting. First, the equity variable is not significant (in any of the cities): there is, surprisingly, apparently no correlation between respondents’ opinions about equity and their opinions about congestion pricing. In the light of this, the preoccupation with congestion charges’ equity effects is rather remarkable – unless it is simply because supposedly negative equity effects is a more convenient argument against congestion charges in public debate than self-interest arguments. Second, there are no differences in the parameters for the attitude variables across income groups. In other words, attitudes affect voting responses in the same way, regardless of income. It might have been natural to expect that, for example, rich groups could “afford” to let, say, environmental concerns affect their attitude to congestion pricing more than poor groups – but this is apparently not the case.

The model in Table 7.7 shows how self-interest variables and the various “citizen perspective” variables are weighted against each other. This means that we can now interpret the underlying latent variable as an extended “utility function” comprising two parts: a consumer part (consisting of the self-interest variables) and a citizen part (consisting of the citizen perspective variables). Note that this is an exploratory analysis, and the same caveat applies as noted previously: there is in principle no guarantee that the latent variable can be interpreted cardinally. However, exploring its average over income groups will give an indication of how attitudes are affected by consumer and citizen aspects, and how this varies across income groups. The robustness of the conclusions has also been checked with two other methods (a binary logit model and a predicted-response method; see endnote 5).

Figure 7.9. **Consumer and citizen components of the "utility" of congestion pricing, separated by income group**

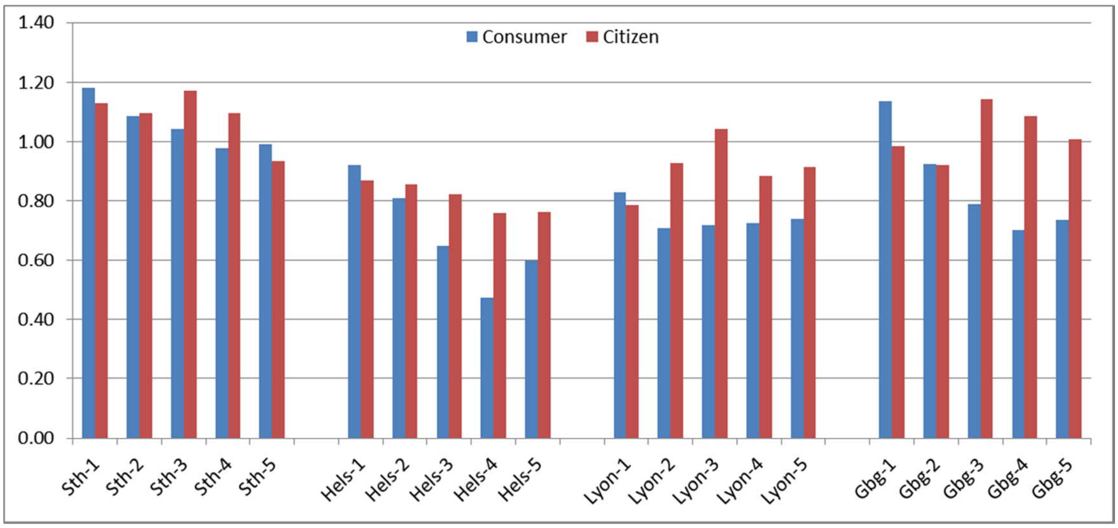


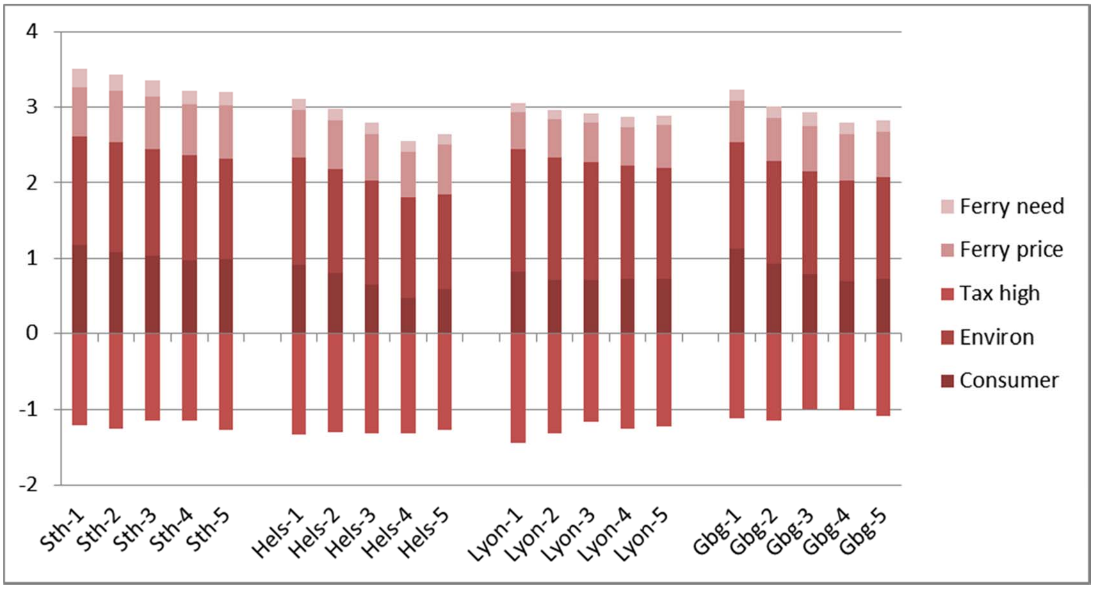
Figure 7.9 illustrates the citizen and consumer components of this "extended utility function" of congestion pricing. The blue bars (the "self-interest" or "consumer" component) are essentially the same as in the analysis of compound self-interest (Figure 7.7) but not rescaled with the average in each city. As was noted before, the general tendency is that low-income groups fare better compared to the average in each city in terms of the self-interest component, although the highest income group actually fare better than the second-to-highest.

The red bars – the "citizen" part – is the new part. Remember that this part of the "utility" function can be interpreted as how well congestion pricing is aligned with individuals' opinions about environmental policy, fairness of pricing as an allocation instrument, the level of taxation and trust in government. An individual who scores highly on these attitudes will tend to be a "winner" in a citizen sense (controlling for the self-interest component) if congestion pricing is introduced, in an analogous way as an individual with high value of time, low toll payments and so on will be a "winner" in a consumer sense (controlling for the citizen component)

The citizen effects are clearly different across income groups. Except for Helsinki, the general tendency is that the middle income group "wins" more than the low- and high-income groups. In Helsinki, income groups simply "win" more the lower income they have.

To explain this in more detail, Figure 7.10 separates the "citizen utility" into its subcomponents. Analysing this in detail shows that the reason that middle-income groups are "winners" from a citizen perspective is primarily because they are the most content with current tax levels, and also rate environmental concerns highly (on par with the lower income groups but slightly higher than the two highest income groups). It is also evident that the attitude variables, taken separately, have a very strong impact on attitudes. Whether congestion pricing is perceived as, for example, mostly an environmental policy or mostly as a tax will hence have a vast impact on support for congestion charges.

Figure 7.10. **Consumer and citizen components of the "utility" of congestion pricing, with "citizen utility" separated into its subcomponents, and separated by income group**



Is congestion pricing fair from a citizen perspective?

Given these results, can congestion pricing be considered "fair" from a citizen perspective? Our conclusion would be a qualified "yes". Clearly, congestion pricing is not more aligned with the citizen preferences of the "elite", defined as the high(est) income groups. In three of the case cities, it is the middle income group who seem to "win" the most in a citizen perspectives; put differently, it is in this group that congestion pricing most closely aligns with the group's societal preferences. Perhaps the most important result, however, is that most differences in citizen preferences are small or negligible across income groups. Consequently the distribution of "citizen utility" is rather similar across groups.

The only social issue where there is a clear difference in opinions across income groups is equity. Lower income groups agree to a much larger extent that society needs to prioritise to reduce the gap between rich and poor. However, this turns out not to be related to the congestion pricing issue: there is no correlation between views of equity in any of the case cities.

Conclusions

The purpose of this chapter has been to discuss and analyse to which extent congestion pricing can be viewed as fair. Since "fairness" can be interpreted in several different ways, a range of different analyses have been presented.

Starting with the consumer perspective on fairness, the incidence of toll payments is strongly correlated with income: high-income groups pay more in tolls, on average, in all cities. However, since car driving tends to increase less than proportionately with income, low-income groups tend to pay more tolls relative to their income, on average. A Suits index calculation shows that all of the four analysed congestion charging systems are regressive. Whether this is a problem depends, in my view, on the purpose of the charges. If the purpose is truly to correct the price of car driving, to make it reflect the full social cost of driving, then it is in fact doubtful whether distributional effects are relevant, at least in the long run. Amending income inequalities through taxation and welfare systems is both more effective and efficient than subsidising goods; and allowing prices to be lower than the social cost is equivalent to a social subsidy. However, congestion charges often have dual purposes: in addition to being a corrective tax, the purpose is often also (and sometimes primarily) to generate revenues, often for infrastructure investments. To the extent that the charges is a fiscal measure, the potential regressivity of congestion charges is a serious problem. After all, it is difficult to see why the poor should contribute more than proportionately to public tax revenues.

The distributional profile of congestion pricing depends on the design of the specific system – location of charging points or areas, exemptions, time of day and so on. An illustrative example is the Swedish (unintended) exemption for company cars, which turned the Gothenburg system from an almost equity-neutral to a clearly regressive system.

In a second analysis, the consumer perspective was broadened from merely toll payments to a range of variables relating to self-interest: access to car in the household, value of time savings and the number of car trips. The weights of the different variables were obtained by estimating their impact on individuals' attitudes to congestion charges (how they would vote in a congestion pricing referendum). One interesting finding is that income hardly matters for how these variables affect attitudes to congestion charges; their impact on attitude is almost the same across all income groups (except the lowest group). With these weights, a compound self-interest measure was calculated, and its incidence across income groups was explored. Broadly speaking, this analysis showed that congestion pricing is "progressive" (with a slight abuse of the term) in the sense that lower income groups are hurt less than average by the direct, self-interest effects, as perceived by the individuals themselves. The exception is Lyon, but the reason for this seems to be the coarse design of the system: a more realistic and efficient design may well have yielded other results.

Fairness can also be viewed in a citizen perspective. Depending on individuals' views of procedural fairness, equity, environmental issues and so on, congestion pricing can be viewed as more or less "fair" in an abstract sense, disregarding its objective, "consumer" effects. A "winner" on a congestion pricing reform in a citizen sense is hence someone who approves of the underlying, abstract logic and rationale of congestion pricing – whose views of fairness, environment and other societal dimensions are aligned with what congestion pricing represents (for that individual). In order to estimate this "citizen utility", a model was estimated that separated how self-interest variables and attitude to various societal issues – environment, taxes, pricing as an allocation instrument, equity and trust in government – affected attitudes to congestion pricing. This allowed for an even broader definition of the "utility" of a congestion pricing reform, capturing both consumer and citizen components. The distribution of these "utility components" across income groups can then be explored.

This analysis showed that in terms of "citizen utility", it is in fact middle-income groups who fare better than average, with the exception of Helsinki, where groups fare better (relative to the average) the lower their income is. Differences across income groups are relatively small, however.

In summary, it is hard to find much support of the view that congestion pricing is unfair, as long as its purpose is to correct prices and allocate scarce resources. Both in terms of absolute payments and compound self-interest, lower income groups fare better than average. From a citizen perspective, differences are small, but lower income groups fare at least as well (and in some cases better) than high-income groups. This changes, however, if the purpose of a charging system is in fact to generate revenues. In that case, the regressivity of the pricing systems – that poor pay more relative to their income – is a serious problem: it is difficult to defend that poor groups should contribute more than proportionately to public revenues.

Notes

[1] Other terms for essentially the same distinction are "homo economicus" vs. "homo politicus", or "personal well-being" vs. "subjective social welfare".

[2] It can be shown that the relative size of the adaptation cost to the tolls paid, i.e. the "triangle under the demand curve" relative to the "rectangle under the demand curve" (ignoring changes in travel time for the moment), given a relative price change a and demand elasticity ϵ is $a\epsilon/2$. To illustrate magnitudes, assume that a congestion charge increases the monetary cost of an average car trip by 25%, and that the demand elasticity is in the order of -0.5. This would give an adaptation cost which would be around 6% of the toll paid. More careful quantitative analyses, separating welfare effects into time gains, adaptation costs and paid tolls can be found in Eliasson (2009) and Eliasson and Levander (2006).

[3] This is the average toll payment per income class divided by the average income in that class, which is the resolution available in the data. An alternative measure would be the average of (toll payment divided by income), but this causes problems for people with (notional) very low or even zero incomes.

[4] This view is not shared by all, though. At the time I am writing this, a representative of the Swedish Left party is quoted in a newspaper saying "Uniform pricing of trips is a necessary fairness reform. Healthcare costs the same for everyone: travelling should, too." However, it turns out that the view that all trips should cost the same apparently only applies to public transport trips: the Left party is very much in favour of congestion charges.

[5] In Lyon, the hypothetical situation instead involved a closed tunnel, as this was judged to be closer to reality and easier to imagine.

[6] To check the robustness of the conclusions from this exploratory analysis, two other methods are also used. First, a binary model is estimated, grouping the responses into positive or negative, discarding "no opinion". This reduces the problem with different distances between thresholds, since there will, in essence, only be one "threshold". The parameters of this binary model turn out to be close to the ordered logit model, so conclusions stay unchanged. Second, the ordered logit model is used to predict the responses of all the individuals, using only these self-interest variables. This will be a measure of how individuals "should" vote if they only took self-interest into account. (Note that the reasons that this is meaningful is that the model does not incorporate constants for each income group; in that case, the model predictions had simply coincided with the actual average voting responses for each income class.) There is also, as noted above, a risk that parameters are biased since attitudinal variables are omitted. To check that, results are also compared with the model presented below where attitudinal variables are included. It turns out that the parameters of the "self-interest" variables hardly change.

[7] The word "fair" is, it turns out, not always easy to translate. The Swedish survey used the word *rimlig* which can also be translated as "reasonable", "acceptable", "justified".

References

Börjesson, M., Eliasson, J., & Hamilton, C. (2016), "Why experience changes attitudes to congestion pricing: The case of Gothenburg", *Transportation Research Part A: Policy and Practice*, 85, 1–16.

Börjesson, M., Eliasson, J., Hugosson, M. B., & Brundell-Freij, K. (2012), "The Stockholm congestion charges—5 years on. Effects, acceptability and lessons learnt", *Transport Policy*, 20, 1–12.

Börjesson, M., & Kristoffersson, I. (2015), "The Gothenburg congestion charge. Effects, design and politics", *Transportation Research Part A: Policy and Practice*, 75, 134–146.

Center for Public Policy Priorities. (2007), *Who pays Texas taxes?* (No. 287). Center for Public Policy Priorities.

Eliasson, J. (2008), "Lessons from the Stockholm congestion charging trial", *Transport Policy*, 15(6), 395–404.

Eliasson, J. (2009), "A cost-benefit analysis of the Stockholm congestion charging system", *Transportation Research Part A: Policy and Practice*, 43(4), 468–480.

Eliasson, J. (2014), "The role of attitude structures, direct experience and framing for successful congestion pricing", *Transportation Research A*, 67, 81–95.

Eliasson, J., & Jonsson, L. (2011), "The unexpected "yes": Explanatory factors behind the positive attitudes to congestion charges in Stockholm", *Transport Policy*, 18(4), 636–647.

Eliasson, J., & Levander, A. (2006), "Equity Effects of the Stockholm Trial", Transek report.

Eliasson, J., & Mattsson, L.-G. (2006), "Equity effects of congestion pricing: Quantitative methodology and a case study for Stockholm", *Transportation Research Part A: Policy and Practice*, 40(7), 602–620.

Eliasson, J., Pyddoke, R., & Swärdh, J.-E. (2016), "Distributional effects of taxes on car fuel, use, ownership and purchases" (No. 2016:X), *CTS Working Paper, Centre for Transport Studies*, KTH Royal Institute of Technology.

Gaunt, M., Rye, T., & Allen, S. (2007), "Public Acceptability of Road User Charging: The Case of Edinburgh and the 2005 Referendum", *Transport Reviews*, 27(1), 85–102.

Greene, W. H. (2003), *Econometric analysis*. Prentice Hall.

Hamilton, C. J., Eliasson, J., Brundell-Freij, K., Raux, C., & Souche, S. (2014), "Determinants of congestion pricing acceptability" (No. 2014:11), *CTS Working Paper, Centre for Transport Studies*, KTH Royal Institute of Technology.

Hårsman, B., & Quigley, J. M. (2010), "Political and public acceptability of congestion pricing: Ideology and self-interest", *Journal of Policy Analysis and Management*, 29(4), 854–874.

Jaensirisak, S., May, A. D., & Wardman, M. (2003), "Acceptability of Road User Charging: The Influence of Selfish and Social Perspectives", in J. Schade and B. Schlag (eds.): *Acceptability of Transport Pricing Strategies*. Elsevier, Oxford.

Karlström, A., & Franklin, J. P. (2009), "Behavioral adjustments and equity effects of congestion pricing: Analysis of morning commutes during the Stockholm Trial", *Transportation Research Part A: Policy and Practice*, 43(3), 283–296.

Le Vine, S., Jones, P., & Polak, J. (2013), "The Contribution of Benefit-in-Kind Taxation Policy in Britain to the “Peak Car” Phenomenon", *Transport Reviews*, 33(5), 526–547.

Levinson, D. (2010), "Equity Effects of Road Pricing: A Review", *Transport Reviews*, 30(1), 33–57.

Metcalf, G. E. (1996), "The lifetime incidence of state and local taxes: measuring changes during the 1980s", in J. Slemrod (Ed.), T*ax progressivity and income inequality*. Cambridge University Press.

Nyborg, K. (2000), "Homo Economicus and Homo Politicus: interpretation and aggregation of environmental values", *Journal of Economic Behavior & Organization*, 42(3), 305–322.

Sagoff, M. (1988), "The economy of the earth", Cambridge: Cambridge University Press.

Schade, J., & Schlag, B. (2003), "Acceptability of road user charging: meeting the challenge", *Acceptability of transport pricing strategies*, 27.

Small, K. A. (1992), "Using the revenues from congestion pricing", *Transportation*, 19, 359–381.

Suits, D. B. (1977), "Measurement of Tax Progressivity", *The American Economic Review*, 67(4), 747–752.

West, S. E. (2004), "Distributional effects of alternative vehicle pollution control policies", *Journal of Public Economics*, 88(3–4), 735–757.

Annex 7.1. Estimation results.

```
Ordered logit model, self-interest variables only

                              Value Std. Error t value
toll                     -0.0010832  0.0001125 -9.6249
Toll, inc.grp 1          -0.0007957  0.0002209 -3.6030
No car                    0.3061705  0.0610495  5.0151
cartrips                  0.4306097  0.0284951 15.1117
Value of time, drivers    0.2389846  0.0189181 12.6326
Stockholm                 0.9948645  0.0668150 14.8898
Helsinki                  0.0213867  0.0740519  0.2888
Lyon                     -0.1766564  0.0722816 -2.4440
Gothenburg2014            0.5572110  0.0697637  7.9871

Intercepts:
    Value   Std. Error t value
1|2  0.4265  0.1022     4.1721
2|3  1.4528  0.1034    14.0502
3|4  1.9839  0.1047    18.9533
4|5  3.3649  0.1098    30.6583

Residual Deviance: 19960.01
AIC: 19986.01
```

```
Binary logit model, self-interest variables only

                           Estimate Std. Error z value Pr(>|z|)
(Intercept)              -1.9731613  0.1347027 -14.648  < 2e-16 ***
toll                     -0.0009835  0.0001451  -6.778 1.22e-11 ***
Toll, inc.grp 1          -0.0013063  0.0003366  -3.881 0.000104 ***
No car                    0.3865780  0.0772495   5.004 5.61e-07 ***
cartrips                  0.4892545  0.0365803  13.375  < 2e-16 ***
Value of time, drivers    0.2467155  0.0239912  10.284  < 2e-16 ***
Stockholm                 1.2330181  0.0881791  13.983  < 2e-16 ***
Helsinki                  0.1313171  0.0977848   1.343 0.179298
Lyon                     -0.0158074  0.0914899  -0.173 0.862827
Gothenburg2014            0.6557825  0.0907974   7.222 5.10e-13 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 8367.4  on 6078  degrees of freedom
Residual deviance: 7229.9  on 6069  degrees of freedom
  (1011 observations deleted due to missingness)
AIC: 7249.9
```

```
Ordered logit model, self-interest and attitude variables

                              Value Std. Error  t value
Tolls                    -0.0010111  0.0001179  -8.5742
Tolls, add. inc.grp 1    -0.0005993  0.0002281  -2.6274
No car                    0.3297529  0.0641394   5.1412
Car trips                 0.3327746  0.0302396  11.0046
Value of time, drivers    0.1825060  0.0199794   9.1347
Stockholm                 1.0063928  0.0713684  14.1014
Helsinki                  0.1555103  0.0780314   1.9929
Lyon                     -0.0990411  0.0771785  -1.2833
Gothenburg2014            0.5615992  0.0776810   7.2296
environ                   0.2609645  0.0166537  15.6701
TaxTooHigh               -0.2524060  0.0118604 -21.2813
PricingIsFair             0.1172166  0.0114416  10.2447
AgencyIsFair              0.0504215  0.0098760   5.1054
equity                   -0.0042233  0.0134644  -0.3137

Intercepts:
    Value    Std. Error t value
1|2   1.0315   0.1610     6.4059
2|3   2.1687   0.1627    13.3295
3|4   2.7289   0.1639    16.6526
4|5   4.2695   0.1684    25.3584
```

```
Residual Deviance: 17698.47
AIC: 17734.47
```

```
Binary logit model, self-interest and attitude variables

                          Estimate Std. Error z value Pr(>|z|)
(Intercept)             -2.9264067  0.2270337 -12.890  < 2e-16 ***
Tolls                   -0.0009104  0.0001588  -5.735 9.77e-09 ***
Tolls, add. inc.grp 1   -0.0009653  0.0003484  -2.770   0.0056 **
No car                   0.4413697  0.0867175   5.090 3.59e-07 ***
Car trips                0.3767392  0.0406581   9.266  < 2e-16 ***
Value of time, drivers   0.1845074  0.0268289   6.877 6.11e-12 ***
Stockholm                1.3605294  0.1002557  13.571  < 2e-16 ***
Helsinki                 0.3196677  0.1084253   2.948   0.0032 **
Lyon                     0.1205585  0.1029584   1.171   0.2416
Gothenburg2014           0.6459297  0.1068889   6.043 1.51e-09 ***
environ                  0.3026574  0.0230508  13.130  < 2e-16 ***
TaxTooHigh              -0.2899107  0.0160354 -18.079  < 2e-16 ***
PricingIsFair            0.1538182  0.0158089   9.730  < 2e-16 ***
AgencyIsFair             0.0664233  0.0135873   4.889 1.02e-06 ***
equity                  -0.0224911  0.0179744  -1.251   0.2108
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 7943.2  on 5766  degrees of freedom
Residual deviance: 6066.0  on 5752  degrees of freedom
  (1323 observations deleted due to missingness)
AIC: 6096
```

Participants list

Mr. Peter JONES — Chair
Professor of Transport & Sustainable Development; Director, Centre for Transport Studies
CEGE
University College London (UCL)
Chadwick Building, Gower Street
WC1E 6BT London
United Kingdom

Mr. Jonas ELIASSON — Rapporteur
Director, City of Stockholm
and Professor, KTH Royal Institute of Technology
Wadköpingsvägen 3
168 39 Bromma
Sweden

Mr. Erick GUERRA — Rapporteur
Assistant Professor
City and Regional Planning
University of Pennsylvania
127 Meyerson Hall
210 S. 34th Street
PA 19104-6311 Philadelphia
United States

Mr. Ricardo HURTUBIA — Rapporteur
Assistant Professor
Department of Transport Engineering and Logistics
Pontificia Universidad Católica de Chile
Vicuña Mackenna 4860
Macul
Chile

Ms. Tatiana PERALTA QUIROS — Rapporteur
Urban Mobility and Technology
Transport & ICT, Global Practice
World Bank - USA
1818H St NW Washington DC
United States

Mr. Alan PISARSKI Rapporteur
Independent Consultant
Alan Pisarski Consulting
6501 waterway drive
22044 FALLS CHURCH
United States

Ms. Camila RODRIGUEZ HERNANDEZ Rapporteur
Senior Infrastructure Specialist
Transport & ICT, Global Practice
The World Bank
Carrera 7 No. 71-21 Torre A, Piso 16
Bogotá
Colombia

Ms. Geetam TIWARI Rapporteur
Professor
Civil Engineering / Transportation Research
Indian Institute of Technology Delhi
MS 808, IIT Delhi, Hauz Khas
110016 Delhi
India

Mr. Ignacio TIZNADO Co-Rapporteur
MSc Student
Transport and Logistic's department
Pontificia Universidad Católica de Chile
Camino Otoñal Oriente 5657
Santiago
Chile

Mr. Geunwon AHN
Research Fellow
Division of Transport Economics Research
Korea Transport Institute (KOTI)
370 Sicheong-Dearo
339007 Sejong-Si
Korea

Mr. Scott BERNSTEIN
President
Center for Neighborhood Technology
2125 W. North Ave
60647 Chicago
United States

M. Akli BERRI
Researcher
Laboratory Economic and Social Dynamics of Transport (DEST)
French Institute of transport science and technologies, regional development and networks (IFSTTAR)
14-20 Boulevard Newton, Cité Descartes, Champs-sur-Marne
77447 Marne-la-Vallée
France

Ms. Maria CONILL
Civil Engineer
Mobility and Transport Department
Metropolitan Area of Barcelona
c/62, No. 16-18 Zona Franca
08040 Barcelona
Spain

Ms. Claudia DIAZ DIAZ
Lider de Transporte Metropolitano
Subdirección de Movilidad
Área Metropolitana del Valle de Aburrá
Cr 53 No. 40A-31
Medellin
Colombia

Mrs. Floridea DI CIOMMO
Responsible for Research; Chair of Transport and Equity Analysis Cost Action TU1209
Sustainable Mobility and Travel Behaviour
Universidad Politecnica de Cataluña
C. Jordi Girona, 1-3 Building C3-S120
08034 Barcelona
Spain

Mr. Onésimo FLORES DEWEY
Visiting Scholar
Center for Advanced Urbanism
Massachusetts Institute of Technology (MIT)
126 Harvey Street
02140 Cambridge
United States

Mr. Clayton LANE
Chief Executive Officer
Institute for Transportation and Development Policy
9 East, 19th Street, 1st Floor
10003 New York
United States

Mr. Todd LITMAN
Executive Director
The Victoria Transport Policy Institute
1250 Rudlin Street,
V8V 3R7 Victoria
Canada

Ms. Manuela LOPEZ MENENDEZ
Secretaria de Obras de Transporte
Ministerio de Transporte de la Nación
Hipólito Yrigoyen 250 of 1229
Buenos Aires
Argentina

Dr. Kylie LOVELL
Principal Research Officer
Social and Behavioural Research
Department for Transport (DfT)
Great Minster House
33 Horseferry Road
SW1P 4DR London
United Kingdom

Ms. Sofia MARTIN-PUERTA
Consultant
Polygonia
10 Rue Aristide Briand
92130 Issy les Moulineaux
France

Mr. Haixiao PAN
Professor
Department of Urban Planning
Tongji University
1239 Siping Road
200092 Shanghai
People's Republic of China

Mr. Ivan SARMIENTO
Professor
Department of Civil engineering
Universidad Nacional de Colombia
Calle 65 No. 78-28, Oficina M1-223
05001000 Medellin
Colombia

OECD

Mme Soo-Jin KIM
Policy Analyst
GOV/RDP
OECD
2 rue André-Pascal
75016 Paris
France

Mr. Alexander LEMBCKE
Economist/Policy Analyst
GOV/RDP

M. Sebastian NIETO PARRA
Economist
DEV/GD/LAC

Ms. Magdalena OLCZAK
Project Manager
ITF/IRS

Miss Ana Maria RUIZ
Policy analyst Junior
GOV/BUD

ITF Research and Policy

Mr. Stephen PERKINS
Head of Research & Policy Analysis
International Transport Forum / OECD
2 rue André-Pascal
75016 Paris
France

Ms. Aimee AGUILAR JABER
Economist

Mr. Guineng CHEN
Transport Analyst

Ms. Jagoda EGELAND
Economist

Ms. Wei-Shiuen NG
Transport Analyst

Mr. Christian POLLOK
Transport Analyst

Mme Monserrat FONBONNAT
Assistant

Income Inequality, Social Inclusion and Mobility

There is significant evidence across countries that lower-income populations tend to suffer more from restricted transport options, have lower quality transport services available to them and travel under worse conditions (safety, security, reliability, comfort). Broad evidence also suggests that the lack of, or poor access to, transport options is central to limitations on access to jobs, educational institutions, health facilities, social networks, etc., which in turn generates a "poverty trap".

This Roundtable report examines mobility policies with a focus on evaluating their capacity to address transport-related exclusion of lower income groups.

International Transport Forum
2 rue André Pascal
75775 Paris Cedex 16
France
T +33 (0)1 45 24 97 10
F +33 (0)1 45 24 13 22
Email : contact@itf-oecd.org
Web: www.itf-oecd.org