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Putting the Passenger First: What Works and What Does Not Work in Urban Mobility Reforms in Latin America and the Caribbean*

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Abstract

The Latin American and Caribbean region offers a rich history of innovative policies and investments in urban mobility. We review some of these experiences with the aim of extracting lessons that can provide guidance to policymakers in the design and implementation of successful urban transport reforms. Special emphasis is placed on users' welfare and how different policies impinge on their interests and behavior. Many reforms have faced difficulties by not considering the consequences of policy initiatives on users' welfare, especially their impact on time costs. Another relevant theme discussed in this document is that modern high-quality transit systems are expensive and fare revenues will generally not be sufficient to fund an ambitious reform. If public funds are not available, it is advisable to reduce the scope and scale of reform. Fortunately, there are many low-cost options to improve urban mobility. Furthermore, some pricing policies can improve mobility while raising revenues at the same time; resources that can then be used to subsidize transit services. While the optimal policy package will depend on the specific circumstances of each city and the available funding, what cannot be overlooked is the interest of users and passengers. Policymakers must always place themselves in their shoes and think through how their intended intervention will affect their travel experience, time and financial cost.

Contents

1 Introduction

The general aim of this document is to provide guidance to policymakers in the design and application of transport policies based on what has and what has not worked in urban mobility reforms in Latin America and the Caribbean (LAC). As argued in this review, urban mobility not only directly improve people's lives –through better access to labor, education, health and recreational opportunities– but is also a fundamental component for economic development. Without the efficient movement of people and goods across geographical space, productivity growth is impaired.

The region offers a rich history of innovative policy experiences that are worth reviewing. The bus rapid transit (BRT) revolution across the world is essentially a result of the successful pioneering experiences in Curitiba, Brazil, and later in Bogotá, Colombia. Other innovative reforms include the introduction of cable-cars as a mass transit mode in Medellín, Colombia, and La Paz, Bolivia, among others.

However, not all urban transport policies have been successful. The 2007 Transantiago transit reform in Santiago, Chile, is a case in point. This reform created a mobility and political crisis that reverberates to this day. In Santiago –as well as other cases to be reviewed below– it has taken time and substantial financial resources to amend the initial design problems and finally provide transit services that operate reasonably well.

In other cases, policies have probably been counterproductive. For example, many cities in the region have applied license plate restrictions in an effort to reduce traffic congestion. However, these policies promote the purchase of additional, often older, automobiles. Thus, over time, air and noise pollution have been exacerbated without significant gains in terms of congestion reduction. These restrictions are also economically inefficient by suppressing high-valued automobile trips.

The ingenuity in designing novel and innovative policies in the region has once again provided some creative and interesting alternatives related to this last issue. Recently, in the Colombian cities of Cali and Bogotá, an exemption charge was introduced in their license plate restriction schemes, effectively transforming these restrictions into a type of congestion charge system, a more efficient alternative for combating congestion. Additionally, some vintage car restrictions, as in Santiago, have provided incentives to accelerate car renewal, resulting in a newer and environmentally cleaner automobile fleet.

In a review such as this, not all topics can be covered. We do not address governance and institutional aspects, implementation strategies, communication and political consensus and many other issues that determine the success of a transit reform. This omission should not detract from their importance. They are crucial to the tactical implementation of reforms and are well treated in other sources.[1] Rather, in this document we take a more strategic view of the fundamental aspects that must be considered in the design of urban mobility policies and investments.[2] What we discuss in this review may not be sufficient, but they are certainly necessary elements that any reform must consider. Policies designed without a clear understanding of the strategic issues discussed in this paper may falter; regardless of how effectively they are implemented.

There are two main points we wish to convey in this review. First, as previously mentioned, urban mobility is not only important for the quality of life and access to social and economic opportunities, but also relevant for economic efficiency and growth. Second, any reform should have as its prime objective to improve users' welfare, particularly transit passengers.

This last point may be somewhat obvious for a policy that aims to improve mobility, but in some cases transit reforms have prioritized secondary objectives or confused instruments with objectives (e.g., new buses, modern and high quality infrastructure, payment mechanism, formalizing operators). Without a clear sense of what really matters to passengers, original demand projections may be grossly overestimated, resulting in financial difficulties once a new project is in operation. In other cases, such as license plate car restrictions and other command and control regulations, policymakers must consider how individuals will react when faced with these policies. These

[1]See, for example, Ardila-Gomez and Darido (2024); Calatayud et al. (2022); Hoyos Guerrero and Lopez Dodero (2021); Pulido et al. (2021); Jehanno et al. (2018); Lane (2017); Hidalgo and Carrigan (2010).

[2]This document also complements other research on this topic undertaken at the IADB. See for example Yañez-Pagans et al. (2019).

behavioral changes must be taken into account when pondering the relative merits of alternative policy options.

This paper serves as a call for policymakers to think through how a proposed reform will affect users' interests. Otherwise, unexpected behavioral changes may ensue, jeopardizing the success of the policy intervention as illustrated by several regional experiences below. What do users stand to gain in terms of travel times, comfort and financial costs? Will they change their behavior in ways that compromise the expected outcomes of the policy? Thinking through these and other issues is a key first step to a successful mobility reform.

Despite the above warning, there are sufficient positive experiences in the region to end this introduction on a positive note. It is certainly possible to design and implement an effective mobility reform that can not only improve people's lives directly but also boost economic and sustainable development. There are plenty of "win-win-win" opportunities (good for people, good for the economy and good for the environment) in the context of urban mobility policies.

This paper is structured as follows. In the next section, we discuss why urban mobility is important for economic growth and social well-being. We follow with a conceptual discussion of the determinants of users' welfare and their behavioral reaction to different policies. We then present an overview of LAC experiences and available research. By mobility policies we will refer both to infrastructure investments as well as pricing, tax and subsidy schemes. The document ends with a summary of the main conclusions of this review.

2 Urban mobility: why it matters

Calatayud et al. (2021) report that large Latin American metropolis –such as Bogotá, Lima, Mexico City and Rio de Janeiro– are among the most congested in the world. In these cities, workers have to endure long daily commutes, often using uncomfortable and unsafe informal transport. Calatayud et al. (2021) estimate the value of excess travel times due to congestion to be between 0,55% and 1,12% of GDP in LAC cities (Table 1).

Table 1: The time cost of urban congestion in Latin American cities

	Hours lost per traveler (h/year)	Value of time lost (US$/year/traveler)	Loss relative to GDP (%)
Bogotá	189	340	0.88%
Buenos Aires	45	249	1.12%
Lima	148	224	0.79%
Mexico City	66	119	0.55%
Montevideo	121	474	1.10%
Rio de Janeiro	54	162	0.88%
San Salvador	83	57	0.55%
Santiago	76	409	1.04%
Santo Domingo	36	86	0.67%
Sao Paulo	68	205	1.12%

Source: Calatayud et al. (2021).

Congestion is also an important barrier to access education and labor opportunities, as well as health and government services. This barrier disproportionately affects the poor, who tend to reside in the periphery of cities in LAC.[3]

The above issues should be sufficient to justify urban transport reforms. Improving mobility has a direct impact on the quality of life and economic well-being of citizens, especially the poor. Less well known is that it also enhances productivity and economic growth. Someone once remarked that urban mobility is analogous to a "free-trade agreement" within a city.

How does mobility improve productivity and growth? First, it reduces logistical costs, boosting trade and competition in input and final goods markets within a city. This is particularly important for the labor market. Box 2.1 summarizes the results of a recent study indicating how the expansion of Santiago's subway made the labor market more competitive.

[3]See Gómez-Lobo and Oviedo (2023) and the references therein for a discussion of spatial segregation in LAC cities.

Box 2.1: The impact of the expansion of the Santiago Metro on the labor market

The subway network in Santiago (*Metro de Santiago*) grew from 52 stations and 40 kilometers in 2000 to 136 stations and 140 kilometers by 2020 (currently 149 kilometers). Lecaros et al. (2023) use data from a large panel of workers to study the impact of this expansion on labor market outcomes.

They find that after the metro expanded to a certain zone, a higher proportion of workers residing there started working further away, increasing their labor earnings. The interesting finding is that workers who did not switch jobs also started earning more. Likewise, firms located in districts where the metro expanded started hiring workers who resided farther away.

Lecaros et al. (2023) interpret this evidence by arguing that the greater mobility provided by metro access generated a wage equalization process across the city. This price convergence phenomenon is a tell-tale sign of a more competitive and better functioning labor market. With impaired mobility, firms had (monopsony) market power to lower wages of workers with limited access to other jobs, while firms located in hard to access zones had to pay higher wages to attract workers. Metro expansion made the labor market more competitive and homogeneous.

The authors of the study note that the "wage equalization we observe is equivalent to the convergence of tradeable-goods prices after trade costs decrease" echoing our comment in the text of thinking of urban mobility improvements as a free-trade agreement within a city.

There are other reasons why better mobility increases productivity and economic growth. Research has shown that firms and workers in larger cities tend to be more productive. This is attributed to various urban agglomeration economies recognized at least since Alfred Marshall in the 19th century. These are related to more specialization in production, better matching between workers and firms, better matching between input suppliers and producers, the sharing of indivisible local infrastructure, and the dissemination of ideas (Duranton and Puga, 2004). It is not easy to apportion productivity gains among each of these potential explanations but it is an empirical regularity that wages (a measure of productivity) are higher in larger or denser cities.[4]

LAC evidence corroborates the above empirical regularity. Table 2 presents results from existing studies. These use different data, definitions of geographical size (or density) and methodologies, but they all find a positive productivity or wage elasticity from higher city size/density. An elasticity of 0.05 (roughly the average found for the region) implies that wages (as a proxy for productivity) will be 12% higher in a city that is 10 times larger than another. This is a significant agglomeration effect.

Table 2: Summary of estimates of agglomeration economies in LAC

Study	Country	Agglomeration elasticity	Comments
Barufi et al. (2016)	Brazil	0.05-0.09	
Chauvin et al. (2017)	Brazil	0.026	Microregions
Silva and Azzoni (2022)	Brazil	0.043-0.057	
Duranton (2016)	Colombia	0.054	
Matano et al. (2020)	Ecuador	0.71	Formal sector
Del Carpio and Patrick (2021)	Peru	0.06-0.08	Informal firms
		0.02-0.06	Formal firms
Gómez-Lobo et al. (2022b)	5 LAC countries	0.05	
Quintero and Roberts (2023)	16 LAC countries	0.025-0.05	

Mobility will impinge on the effective size of a city. The easier and faster people and goods can travel within a city, the bigger its economically relevant size and thus the benefits of agglomeration economies.[5] Consistent with this

[4]See Duranton and Puga (2020) and Combes and Gobillon (2015) for a review of this evidence.

[5]Bertaud (2018) argues that the extent of a city's labor market is determined by the number of jobs that on average workers can reach within one hour of commuting. Thus, the economically relevant size of a city is not exclusively determined by its geographical size or population density. It will also depend on how fast workers can move throughout the city. Mobility improvements increase the size of the labor market, fostering innovation and productivity growth.

idea, Gómez-Lobo et al. (2022b) find evidence that congestion may counteract these economies in LAC cities. Therefore, reducing congestion through mobility improvements should increase the economically relevant size of a city, increasing productivity and wages.

Transport is also related to negative externalities such as air and noise pollution and traffic safety. The main challenge of transport policies is to reap the benefits of better mobility while minimizing or reducing these external costs. One way to achieve this is by promoting public transport use. This is a "win-win-win" strategy, generating direct benefits to urban citizens while at the same time reducing environmental externalities and promoting economic growth. Therefore, it should be a central component of a mobility reform and will be a prominent topic throughout the rest of this document.

3 What do we want from reforms? Prioritizing the passenger

Mobility policies should have as their primary objective to improve users' welfare, particularly in the case of transit passengers. Although this may seem obvious, some reforms in LAC were designed without sufficient attention to this key issue. At the initial stages of a mobility proposal policymakers should take time to answer the following question: what does the policy, investment or reform really offer users?

Answering this question requires an understanding of what travellers care about. This can be roughly classified into three categories:

- *Time costs*: including the time to access the travel mode (e.g., getting to where a private automobile is parked, reaching a bus stop, or arriving at a metro station), waiting time (for the bus, train or metro to arrive once in the station or stop), the in-vehicle time, any transfer time between modes and the time taken to walk from the last mode taken to the final destination. Also, reliability of service –adherence to schedules or an even headway between buses– reduces waiting time and is a characteristic highly valued by users.
- *Financial costs*: the fare in the case of transit, the fuel, maintenance

and vehicle depreciation in the case of private transport and nothing in the case of walking.

- *Comfort and safety*: this includes not only the observable characteristics of travel conditions (e.g., crowding in the case of buses, rail or metro) but also the intrinsic valuation of a certain travel mode (for example, the privacy of private travel versus public transport). This dimension may also differ by gender, with women valuing private transport more when they suffer harassment in public modes. Safety is also a crucial issue in LAC since traffic fatalities in the region are almost twice the level of high-income countries (Martinez et al., 2019).

These three categories determine citizens' well-being in an urban transport context. Critically, the relative value of these characteristics between modes will also determine their travel behavior and thus the effective patronage of a transport mode or service.

In an urban context, time costs are of paramount importance. Although this has long been recognized by experts in the field, many reforms in LAC have encountered problems due to insufficient consideration of this vital issue. Table 3 presents the value of a 5 minute wait by a passenger (say, in a bus stop or station) as a percentage of the fare of transit services in different LAC cities. The first column is the average monthly labor earning from the main occupation in formal employment for 2022.[6] As a rule of thumb, the value of time is often considered to be 50% of the hourly wage rate. For the calculations presented in the table, a 45 hour work week is assumed. Waiting time, as opposed to in-vehicle time, is valued at two to three times the value of time.[7] In the table, waiting time cost is assumed to be 2.5 the value of (in-vehicle) time.

[6] Formal labor earning may overstate overall average earning by not considering informal workers. On the other hand, a national average figure may understate average earning in the large cities considered in Table 3. In any case, the purpose of this table is to give an order of magnitude rather than to make a precise calculation.

[7] See Chapter 2 of Small and Verhoef (2007). Ardila-Gomez and Darido (2024) report that in Quito, passengers value transfer times at four times the value of in-vehicle time. See also Fan et al. (2016).

Table 3: Value of a 5 minute wait as a percentage of transit fares by city

City (currency)	Average monthly labor earnings (2022)	Value of time (per minute)	Value of 5 minute wait	Transit fares (January 2023)	Service	Value 5 min. wait (% of fare)
Buenos Aires (ARS$)	112,376	4.8	60	58.0	Metro	102.9%
Sao Paulo (R$)	3,124	0.1	2	4.4	Metro	37.7%
Santiago (CLP$)	852,298	36.2	453	640.0	Metro	70.7%
				800.0	and bus	56.6%
Quito (US$)	709	0.03	0.38	0.45	Metro	83.7%
				0.60		62.8%
Guatemala City (GTQ$)	5,018	0.21	2.67	1.0	Bus	266.6%
				2.0		133.3%
Montevideo (UYU$)	44,932	1.91	23.87	42.0	Bus	56.8%
				52.0		45.9%

Source: Monthly labor earnings are for formal sector workers and were obtained from the IADB Social Data (https://www.iadb.org/es/recursos-de-conocimiento/datos/datos-sociales, last accessed June 29 2024). Fares obtained from https://www.bloomberglinea.com/2023/01/10/transporte-publico-en-latam-en-que-capitales-es-mas-caro-y-mas-barato/ (last accessed June 29, 2024). Value of time per minute calculated based on monthly earnings assuming (30.5/7) weeks and 45 hours of work per week. Waiting time value assumed to be 2.5 times the value of time. When more than one fare is included for a city it reflects the range of prices for different services or time of use.

From the table, it can be seen that any reform that increases waiting times by 5 minutes –for example, by forcing users to make transfers from feeder services to trunk services– is equivalent to a large increase in the fare, by 38% in the case of Sao Paulo to a doubling of fares in Buenos Aires and even more in Guatemala City. This illustrates how important time costs are for transit users. In many cases, time costs will overshadow the direct financial costs imposed by fares. For buses, time costs are probably more important to passengers than their valuation of new vehicles. No matter how comfortable is a modern new bus or how nice and well dressed the driver is, if it is stuck in traffic or if passengers have to wait a long time for it to arrive at a stop, they will not be better off. This puts into perspective the fact that modernization of transit services in a city does not by itself guarantee a successful reform.

As a unifying conceptual framework, we summarize the above discussion by positing that a user's welfare can be expressed as:

$$W = \theta \cdot U - c_t - c_f$$

where W is welfare, U is the value of a trip for individuals (expressed in monetary terms as the maximum willingness to pay to undertake a trip), θ reflects the comfort of the trip mode, c_t is the time costs and c_f is the financial cost of the trip. The higher the comfort of the trip the higher the welfare of the individual. Likewise, higher time and financial costs lowers welfare for the individual.

We can further disaggregate total time costs into access time (c_{t_a}), waiting time (c_{t_w}) and in-vehicle time (c_{t_v}) costs and express the above equation in more detail as:

$$W = \theta \cdot U - c_{t_a} - c_{t_w} - c_{t_v} - c_f \tag{1}$$

We will use this last equation as the main framework to evaluate urban transport policies. This is not to say that the welfare or interest of other stakeholders are not important (general public, government, gender issues, etc.) but the priority of mobility policies should be to improve the well-being of travellers. Policymakers should think hard how a proposed reform will impinge on each of the above variables and its overall welfare effect for different groups. Sometimes a planner's view of users' welfare may differ from passengers' view, as illustrated by the case of new buses in Santiago (Box 3.1). Thus, planners and policymakers must be careful and listen to what users and operators have to say with respect to proposed reforms. In transit, operators will have very good knowledge of what passengers want and value, and this information should not be overlooked (a point also stressed by Ardila-Gomez and Darido (2024)).

Box 3.1: The difference between users' and planners' valuation of new buses in Santiago

The pre-2007 bus system in Santiago, Chile, exemplified the atomized, informal, and low-quality transit services common in Latin American cities. In an attempt to modernize this system, a reform called Transantiago was designed and implemented in February 2007. We will discuss this reform and its problems (which were many) further below. In this box we will concentrate on the physical characteristics of the vehicles.

One component of the Transantiago reform was the renovation of a large fraction of the bus fleet. The old buses (or "yellow buses" as they were called due to their external color, analogous to color labels in other Latin American cities such as the "red devils" in Panama City) were no more than trucks with a bus chassis. They were very noisy, polluting and required passengers to climb three to four steps to board the bus, which was inconvenient for the elderly and impeded access by individuals with disabilities who used wheelchairs. However, this high floor plan allowed buses to have many rows of four seats, providing close to 80 seats in total (see left picture of Figure B.1 below).

Figure B.1: Seats in pre-reform buses (left) and post-reform buses (right)

Source: From "Interior de Micro Amarilla" by Cruz (nd), Blog Recorrido https://www.blog.recorrido.cl/destinos/micros-amarillas-de-santiago-una-vuelta-al-pasado/ and from "Buses" by MTT (2017), https://mtt.gob.cl/archivos/16170.

In an effort to improve quality, the new Transantiago vehicles were buses –common to other modern transport systems– with low-floor access, lower emissions, and automatic transmission for a smoother ride. However, these buses had fewer seats, and the low floor implied that people had to climb to reach the seats over the wheels. They were not well received by passengers, many of whom now had to travel standing (especially in the articulated high-capacity buses) or found the seats uncomfortable to reach and the hard plastic material slippery and less comfortable than the padded seats of the old buses.

This is an example where the planner's perspective on quality and comfort did not match passengers' interest. More effort should have been placed on determining passengers' preferences rather than assuming that just because a bus was new and modern it would improve travel experience.

Currently, an interesting alternative being tested is the use of modern double-decker buses. These buses have more seats than equivalent high capacity articulated buses and also offer a low first floor plan for easy and inclusive access. However, they are more expensive.

In addition, the success of any transport policy will depend on the behavior of users and the changes in behavior induced by these reforms. In turn, behavioral changes will depend on the benefits derived from available choices. Therefore, understanding what determines users' welfare is key to predicting behavioral changes induced by transport policies, which ultimately determines their success or failure.

To illustrate this last point, assume there are several alternative modes to make a trip. An individual will generally choose the mode that provides the highest satisfaction (welfare). That is, the alternative for which W in equation (1) is highest. Mobility policies will affect the relative value of comfort, time costs and financial costs of the different alternatives, changing people's transport behavior and ultimately their welfare.

In the remainder of this review, we will discuss in greater detail how different investments and reforms affect the determinants of users' welfare. We will begin by examining the impact of investments geared to private transport and whether they offer an effective way to improve urban mobility.

4 Roads and urban highways?

With the growing motorization rates in Latin America and the Caribbean, urban congestion is a serious and increasing mobility problem (Calatayud et al., 2021). The instinctive reaction of policymakers is to expand road space or construct urban highways to accommodate the growing number of cars.

However, there is ample evidence that, by itself, expanding road space for private vehicles may not be a very effective policy to reduce congestion in the medium to long-run.[8] The reason is that it may induce additional traffic that counteracts the initial positive effects of the expanded infrastructure. In certain cases, it may in fact make congestion worse. This is called the Downs-Thompson paradox (Mogridge, 1997; Basso and Jara-Díaz, 2012). In the appendix, a very simple model explaining this paradox is presented. It shows that a major road investment that benefits private car use, may increase rather than decrease congestion and average travel costs.

The above does not imply that road infrastructure investments should never be undertaken. Only that these investments do not guarantee that congestion will be reduced in the medium to long-term, particularly during peak periods. A more promising approach is to promote public transport through private traffic demand management, transit investments, bus priority infrastructure or other regulations discussed below. Therefore, in what follows, we will concentrate on this last set of policies. As mentioned above, this is a "win-win-win" strategy: good for people's quality of life, good for the economy and good for the environment.

We will first discuss mass transit investments, followed by regulations and pricing policies. It should be emphasized that this separation is made strictly for expository purposes. In practice, mass transit and regulation or pricing policies complement each other, and a reform should include multiple strategies to address mobility problems.

[8] See Mogridge (1997); Anupriya et al. (2023); Graham et al. (2014).

5 Mass transit investments

5.1 Subways and commuter rail

Subways and commuting rail are very attractive mass rapid transit (MRT) investments.[9] They have a high passenger capacity and provide a reliable, safe and fast travelway to move people in a city.

It is important to note that it is precisely this last feature that generates the attractiveness of these modes for passengers.[10] Due to the dedicated infrastructure on which they run (e.g., tunnels, elevated viaduct, or surface rail lines) they are unhindered by road congestion or traffic lights. For medium to long distances, the in-vehicle time savings more than compensate for the access and waiting time costs. Maintaining reliability and scheduled frequencies is also easier to achieve with dedicated corridors. Fare integration with other modes further increases welfare by facilitating access through feeder services.

Subways also generate benefits beyond the conventional time and vehicle cost savings.[11] In Box 2.1 we already discussed the wider economic benefits associated with the expansion of Santiago's metro (Lecaros et al., 2023). The mobility improvements attributed to this expansion reduced firms' hiring market power and improved firm-worker matching in the labor market, to the benefit of workers. In the case of Mexico City, Zárate (2022) estimates that a new subway line (Linea B) reduced informality by providing poorer individuals living in the periphery better access to formal sector jobs in the center of the city. The ratio of formal to informal workers increased by 6-7% in areas close to the new stations. There are two wider economic benefits to this reallocation of workers. First, it increases welfare by shifting workers to sectors with stronger agglomeration economies. Second, it reduces the

[9]By commuter rail we mean surface based high-capacity trains that operate in a strictly isolated corridor. High-capacity is somewhat arbitrary but a useful benchmark is over 15,000 peak-hour per direction traffic (phpdt). That is, the number of passengers in the peak-hour in the service direction with the highest load. The discussion that follows applies also to monorails.

[10]They may also have an intrinsic preference for a subway or rail service due to their perceived higher quality in terms of noise and air pollution, among other attributes.

[11]A comprehensive list of these benefits is provided by Litman (2024). In the text we only summarize the available LAC evidence.

inefficient allocation of labor resources across different firms. These two benefits increase the direct welfare gains of the subway line by 30% or 0.45% of Mexico City's GDP.

Despite their obvious attraction, subways and commuting rail projects are expensive and have long development times. Therefore, they are only economical for high density corridors that can guarantee high passenger volumes. Investment costs and passenger numbers will differ significantly based on local conditions, design (e.g., elevated, surface or underground tracks), operating variables, among others. Table 4 presents some operational and cost parameters for various subway lines in Latin America.

Another issue is whether these investments generate positive impacts on property values. There is substantial evidence that this is the case, but we defer this discussion until we review some other mass transit investments (see Section 5.6). Suffice to mention here is that a positive impact on real estate values introduces the possibility of using value capture mechanisms to fund part of the investment associated with metro and rail projects.

To summarize using the conceptual framework discussed above, users' welfare usually increases with these high-capacity travel modes. Access time costs (c_{t_a}) and waiting time costs (c_{t_w}) probably increase –although this will depend on a passenger's alternative travel mode–, in-vehicle time costs (c_{t_v}) decrease significantly given the speeds that these modes can achieve in a dedicated infrastructure, while financial costs (c_f) probably remain the same given that capital investments for such projects are usually funded through public grants rather than fare revenues. Finally, the change in comfort is ambiguous and will depend on the characteristics of alternative travel modes.

However, given the high demand that these mass transit systems achieve, at least during peak-hours, passengers are revealing that they are better off traveling in this mode compared to using an alternative option. We can express this by using equation (1) above, where the size and direction of an arrow indicates the strength and direction of the change in the associated variable:

$$\Big\Uparrow W = \uparrow\downarrow\theta \cdot U - \uparrow c_{t_a} - \uparrow c_{t_w} - \Big\Downarrow c_{t_v} - \uparrow\downarrow c_f \tag{2}$$

Table 4: Operational and cost variables of different subways in Latin America

City	Length (kms)	Investment (US$ mill. per km)	Ridership (mill./day)	Average speed (km/h)	Peak demand (phpdt)
Bogotá[a]	24	90	0.127		
Buenos Aires	64		1.172		
Lima	33	131.0[b]	0.550	36.7	
Medellín	31.3			35.9	48,653
Mexico City	226.5	86.5[c]	3.056	36.0	
Panama	37		0.434	36.9	31,000
Quito	22	95.7	0.201	38.0	
Rio de Janeiro	59	250.0[d]	0.518		
Santiago	149	74.6[e]	2.027	38.5	38,257
Santo Domingo	31		0.348	33.3	
Sao Paulo	104.2	201.0[f]	2.860[g]	30-36	

Source: Cárdenas et al. (2023) for Bogotá ([a]under construction). Santiago: Memoria Integrada Metro 2022 y 2023, Metro de Santiago. Quito: https://metrodequito.gob.ec/metronumeros/. Buenos Aires: passengers is average 2019 for working day (Tablero de Control, Cierre 2019, https://buenosaires.gob.ar/infraestructura/subte). Lima: Informe de Sostenibilidad 2019 (https://www.lineauno.pe). Panama: http://www.elmetrodepanama.com. Santo Domingo: Informe Trimestral de Demanda y Operación, Segundo Trimestre 2024 (http://opret.gob.do). Medellín: Memoría de Sostenibilidad 2022 (http://www.metrodeMedellin.gov.co). Mexico City: https://metro.cdmx.gob.mx/longitud-lineas and for speeds https://metro.cdmx.gob.mx/operacion/mas-informacion/material-rodante (average speed is for rubber-tyred trains); Ridership was obtained from https://datos.cdmx.gob.mx/dataset/afluencia-diaria-del-metro-cdmx and corresponds to the average in 2023. Rio de Janeiro: Relatorio Anual 2023, Metro Río. Sao Paulo: Relatorio Integrado 2023, Companhia do Metropolitano de Sao Paulo and https://transparencia.metrosp.com.br/. Phpdt stands peak-hour per direction traffic and is the maximum in any part of the network. Speed is the weighted average over all lines. The following figures taken from Pardo (2015) are for: [b] Line 2 and ramal Line 4 [c] Line 12, [d] Line 4, [e] Average Line 3 and 6, [f] Line 5. [g] Daily ridership (2023 working day average) and speeds are only for the 71.4 kilometers of the network operated by the Companhia do Metropolitano de Sao Paulo.

In this equation, we indicate that the main driving force increasing users' welfare is the reduction in in-vehicle travel times.

The fact that users will most likely benefit from mass rapid transit investments is not sufficient to undertake all proposed projects. But, if a project is undertaken, the likelihood that ex-ante demand projections will be met is high.[12] A careful analysis should be made at the pre-investment stage to determine whether benefits outweigh costs.

5.2 Trams and light rail

Urban light rail or trams are another alternative to improve public transportation. These have lower capacity compared to subways and commuting rail but are also less expensive to build. There are some experiences in LAC with this mode; for example, the Ayacucho light rail in Medellín (Colombia). Cuenca (Ecuador) and Rio de Janeiro (Brazil) have also built such projects. Table 5 summarizes available data for some existing LAC examples.[13]

However, this mode may be hampered by lower travel speeds unless they enjoy a confined travelway. Trams or light-rail operating in an urban context –where they may have to cross intersections and have interaction with automobiles or even pedestrians– may be relatively slow. This can be seen from Table 5 where available speed data shows that they are roughly half of typical subway speeds and even lower than BRT systems, to be discussed in the next section. They are also less flexible compared to buses. If there is an accident or a train breaks down, the whole line will be affected.

The welfare gains for passengers in terms of time savings are not as high as a subway and benefits may not justify the costs of these projects. This will have to be analysed on a project by project basis, but the point is that the mobility case for this type of transport investment is less clear cut.

For these reasons, we can express the welfare impact on users as:

[12] This does not imply that there are no optimism bias in these type of projects, a point made by Flyvbjerg and others (Flyvbjerg, 2008). However, for urban projects in large LAC cities, demand will most probably be high.

[13] In some cities, such as Quito (Ecuador) and Valparaíso (Chile) there are trolleybus services. We do not cover these in this review.

Table 5: Operational and cost variables of light rail or tram services in operation in Latin America

City	Length (kms)	Investment (US$ mill. per km)	Ridership per day (thousand)	Speed (km/h)	Peak demand (phpdt)
Cochabamba	45.5				
Cuenca	10.7	28.0	20,000	18.3	
Guadalajara	45.5				
Medellín	4.2			13.3	3,807
Mexico City	25.0		68,881		
Rio de Janeiro	28.0		110,000		
Santos	11.5				

Source: Cuenca: Wikipedia. Medellín: Memoría de Sostenibilidad 2022 (http://www.metrodemedellin.gov.co). Mexico City: https://www.inegi.org.mx/temas/transportes/ ridership is daily average calculated for 2023. Rio de Janeiro: https://www.uitp.org/data/. Phpdt stands for peak-hour per direction traffic and is the maximum in any part of the network.

$$?W = \uparrow\theta \cdot U - c_{t_a} - \uparrow c_{t_w} - ?c_{t_v} - \uparrow\downarrow c_f \tag{3}$$

where we denote with a question mark the fact that these projects may not be as convenient as may be thought. They may be considered modern and comfortable, but this may not be enough to compensate for low travel times. Also, they are usually short and for many trips may require expensive transfers to other services to complete a trip, increasing waiting time costs. Thus, the welfare impact for an average user may be ambiguous and as a result, demand projections may not materialize. Careful analysis of these projects at the pre-investment stage is required.

5.3 Bus rapid transit (BRT)

LAC has been a world pioneer in BRT systems. After the successful experiences of Curitiba in the ‘70s and Transmilenio in Bogotá, there has been a world boom in these types of projects. Currently 191 cities around the world have a BRT system in operation moving over 31 million passengers per day (GlobalBRTData.org). The largest share is in LAC, with 64 cities moving over 18 million passengers per day.[14]

[14] However, not all of these are truly BRT systems as will be discussed below.

A BRT is similar to a metro or commuter rail mass transit investment, except that it operates at surface level and runs on wheels (buses) rather than rail. Just like subways, "gold-standard" BRT systems have boarding stations, pre-boarding payment systems and confined busways, but at a fraction of the cost (2 to 10 million dollars per kilometer according to Hidalgo and Garaftieaux (2008)). Some BRTs have reached passenger volumes equivalent to rail and metro systems. For example, the Caracas line of Bogotá's Transmilenio has a peak demand of 49,000 passengers per hour per direction (GlobarBRTData.org). Table 6 presents cost and demand data for selected BRT systems in LAC.

Table 6: Operational and cost variables of gold-standard BRT systems in Latin America

City	Length (km)	Investment (US$ mill. per km)	Ridership (mill./day)	Average speed (km/h)	Peak demand (phpdt)
Bogotá	114.4	8.2[a]	1.840	35.0[b]	49,000
Bucaramanga	17.6		0.072	20.0	4,525
Cali	36.1	7.9	0.471	17.8	13,000
Curitiba	74.1	2.4[a]	0.722	19.1	20,500
Guayaquil	46,6	1.6[a]	0.310	21.5	15,000
Lima	26		0.705	25.5	22.800
Medellín	18		0.060	16.0	3,270
Mexico City	140.0	1.4-8.5	1.240	16.4	12,000
Pererira	15.5	2.9[a]	0.121	20.0	6,900
Quito	71.4	2.0[a]	0.745	17.8	11,700
Rio de Janeiro	168	9.8-25.8	3.535	21.8	65,400

Source: except where noted, all information is from BrtData.org and own calculations based on this data. Investment may include planning cost in some cases and is only for infrastructure in other cases. Investment range is for corridors with information from each city. When several investment figures are available from different sources, the highest value is reported. Speed is weighted average over the network and may include services in non-segregated corridors. Phpdt stands peak-hour per direction traffic. [a] from Hidalgo and Garaftieaux (2008). [b] Estadísticas de oferta y demanda del Sistema Integrado de Transporte Público-SITP-marzo 2024 (www.transmilenio.gob.co).

One drawback of a BRT compared to an underground metro, is that these systems require surface space.[15] There could be alternative uses for this land (linear parks, bike lanes, etc.) and the opportunity cost of allocating it to a BRT may be high. This is especially true in highly consolidated and dense cities with high land values, or cases where expropriations are necessary to construct the BRT infrastructure. In addition, surface BRT lanes can act as a barrier to active mobility modes, such as walking or cycling.[16]

Where feasible, BRT systems can achieve the same economic and environmental benefits of their more expensive rail peers. For example, Tsivanidis (2018) estimates that Bogotá's Transmilenio BRT generated welfare benefits that almost double the conventional time savings of transit investment evaluations. Using a general equilibrium model of residential location choice, employment location choice and commuting mode choice, the transit benefits of Transmilenio include the effects on amenities and firm productivity agglomeration externalities. According to Tsivanidis (2018), this BRT reform accounts for 2.96% to 14.36% of GDP growth in Bogotá between 2000 and 2016.

Theoretical research also indicates that dedicating road space to buses achieves almost the same level of efficiency as an optimal congestion charge to be discussed further below (Basso and Silva, 2014). However, it is important to recognize when and why BRTs are successful. This will also help to put into perspective the sometimes inofficious discussion of whether subways or trains are preferable to BRT systems.[17]

For many trips, a BRT system, like commuter trains or subways, requires passengers to make transfers. This will only be welfare enhancing if the gains in travel speeds over the trunk corridor more than compensate the transfer costs. This requires long BRT corridors and high bus speeds over

[15] This also applies to overground metros or trains.

[16] Other difficulties may be encountered in the construction of dedicated bus infrastructure in important urban arteries. The resistance of existing users and commercial shop owners may compromise the project, as the recent experience in Asunción, Paraguay, shows. Also, there is the additional difficulty of resisting the political pressure to open up the infrastructure to private cars once it is built, as the experience in San Salvador and, to a certain extent, in Tegucigalpa indicates. For these cases, see Navas et al. (2023) and Diaz et al. (2018).

[17] See Litman (2024) for a review of this discussion.

these corridors. This fundamental insight has not always been recognized by policymakers leading to difficulties in some reforms. The most critical example has been Transantiago in the capital of Chile. Box 5.1 summarizes this experience and the difficulties encountered.

Box 5.1: The Transantiago reform

Transantiago was a radical citywide reform in the public transport system of Santiago, Chile.[a] It involved a formalization of operators and drivers, the renewal of the bus fleet, fare integration with the Santiago metro, a feeder-trunk configuration, a contactless payment card system, among many other innovations. However, the reform suffered from three major shortcomings. The first was related to contract design and the incentives it created which, in effect, implied that operators did not comply with the operational plan. This problem was resolved through several contract renegotiations. Details of this issue can be found in Gómez-Lobo and Briones (2014). In this summary, we emphasize two other interrelated problems: cost-recovery through fare revenues and the feeder-trunk network configuration.

Fleet renewal, drivers' labor formalization, technological and payment features introduced, as well as some infrastructure concession payments, implied that the new system was much more expensive than the old informal bus system. These additional costs had to be funded from fare revenues alone, as subsidies were not contemplated in the original design. Since the average fare was not expected to increase, how were revenues and costs made to match? The answer was a radical decrease in the fleet size, from 8,000 buses in the old system to less than 4,500 "equivalent" buses (in terms of capacity) in the new system. However, the number of vehicles was much lower than this last number since a significant proportion of the new fleet were high capacity articulated buses (that counted as two "equivalent" buses of the old system). These buses had lower average cost per passengers and so helped to reduce costs. An additional cost reducing strategy was to redesign the route configuration to a feeder-trunk system that raised transfers from 10% of trips prior to the reform to over 70% of trips after the reform. Thus, at the planning stage fare revenues and costs seemed to match.

The welfare consequences of these changes for passengers were not fully understood.[b] Although there was a master plan for 225 kilometers of exclusive bus priority infrastructure, when the new system became operational in February 2007, only 13 kilometers had been built (11 more were under construction). This implied that the majority of passengers had to make costly transfers without the benefit of in-vehicle time savings in trunk services. This problem was compounded by the fleet reduction (and the introduction of articulated buses) which reduced network coverage and frequencies, significantly increasing access and waiting time costs. Thus, passengers were much worse off than in the old system. Transfers were less costly to and from the subway, which could guarantee reliable frequencies and faster in-vehicle speeds. This, however, collapsed the subway services as passengers naturally opted for this mode to make their trip.[c]

The result was a mobility and political crisis that still reverberates to this day. Transantiago was not a BRT reform. It did not include the dedicated bus priority infrastructure that could guarantee lower in-vehicle times on trunk services as in Curitiba or Bogotá (Transmilenio). As a result, passengers were negatively affected as illustrated by the following equation:

$$\Downarrow W = \Downarrow \theta \cdot U - \Uparrow c_{t_a} - \Uparrow c_{t_w} - c_{t_v} - c_f$$

where the increase in access and waiting time costs were not compensated by lower in-vehicle speeds (except in the subway) or lower fares. Comfort also suffered through overcrowded buses and metro cars.

Subsequently, subsidies were introduced to increase the bus fleet (many electric), the subway network was expanded and a new commuter rail line came into operation. What is now called *Red Movilidad*, has become a Hierarchically Integrated System (HITS) similar in characteristics to those of London, Singapore, Seoul, and Tokyo. Although challenges remain –including a very high rate of fare evasion in buses–

users' evaluation of the transit system is positive.[d]

[a]This summary is based on Gómez-Lobo (2012).

[b]There were exceptions to this. See Morande and Doña (2007).

[c]This problem was exacerbated by the fact that initially the electronic payment card could only be charged in metro stations.

[d]See https://www.mtt.gob.cl/archivos/34132.

As Box 5.1 illustrates, for a bus reform to work, it is critical to avoid implicitly funding the higher costs of a modern system through fleet reductions. Also, to avoid the welfare consequences of additional transfers, bus speeds must be increased in the trunk services. This implies that dedicated bus corridors must be built to guarantee such speeds, as in gold standard BRTs. These two problems affected other reforms, such as the Mibus experience in Panama City and the SITP reform in Bogotá. In both cases –just like Santiago– the fleet size was reduced and more transfers were imposed on users, without the bus priority infrastructure required for higher bus speeds to compensate for the added waiting time costs. The result was that passengers switched to alternative transport modes. This in turn reduced demand below initial projections, generating significant financial deficits for the new systems. The added quality and comfort of riding in new modern buses did not compensate for the added time costs imposed on users. This is a critical lesson to be learned from the LAC experience.

Even "gold standard" BRT systems may encounter difficulties if the length of the trunk corridors are not long enough for the in-vehicle time gains to offset the higher transfer costs. This may be the case in small to medium size cities, as the SITM experience in Colombia shows (see Box 5.2).

Box 5.2: BRTs in medium size cities in Colombia

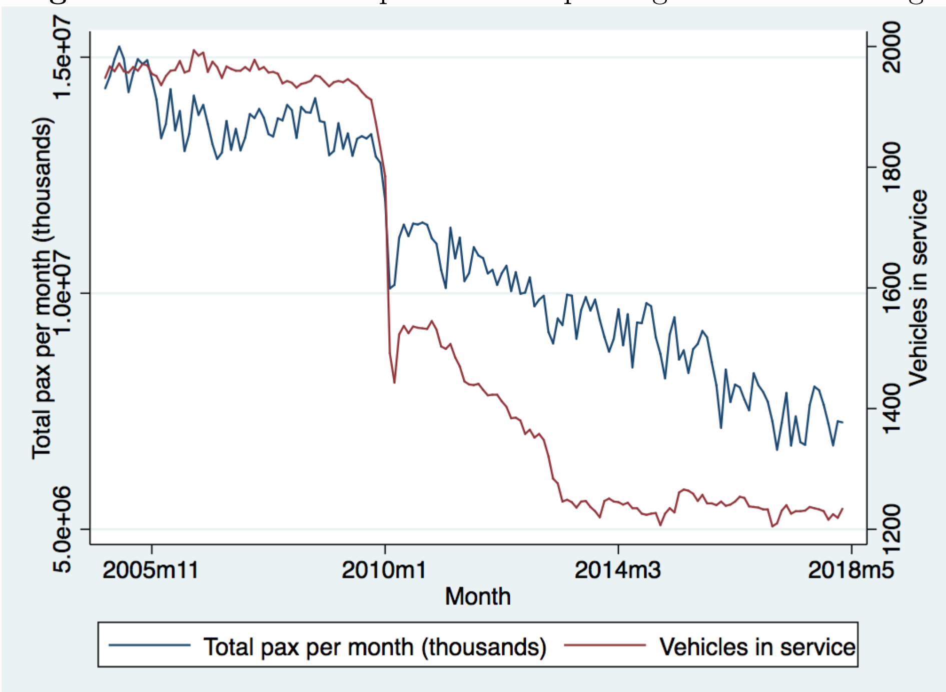
After the successful Transmilenio experience in Bogotá, the Colombian government initiated a plan to replicate "gold standard" BRT systems in small and medium size cities of Colombia.[a] This reform, named Integrated Massive Transit Systems (SITM, by its Spanish acronym), implemented BRTs in six regional capitals: Barranquilla, Bucaramanga, Cali, Cartagena, Medellín and Pereira.

These gold-standard BRTs were smaller than their Bogotá counterpart, from a length of just over 10 kilometers in the case of Cartagena to 18 kilometers in the case of Medellín. Only in the case of Cali was the trunk corridor infrastructure relatively longer, with 36 kilometers. This implies that the in-vehicle time gains in the trunk corridor may not compensate for the imposed new transfers on passengers. For example, assume an average passenger trip length of 10 kilometers. Assume also that average pre-reform speed was 12 km/h, increasing by 50% to 18 km/h with the confined BRT infrastructure. The in-vehicle time savings would be close to 16 minutes. However, if passengers are now forced to make two transfers and assuming these take 5 minutes, the waiting time costs increase by 20 and 30 minutes (2 to 3 times the in-vehicle time costs) and the average passenger is worse off after the reform.

Surely, waiting times could be reduced. But the initial proposal of funding these reforms from fare revenues alone implied –just like the case of Transantiago– a reduction in the fleet size that served to reduce frequencies in both feeder and trunk services. The result was that passengers had incentives to use alternative travel modes. Patronage in these new BRT systems was therefore much lower than initially estimated, from 75.7% of projected demand in the case of Medellín to 22% in the case of Cartagena. Figure B.2 illustrates this dynamics for the case of Bucaramanga. As the SITM reform became operational at the end of 2010, transport supply fell dramatically as did ridership.

The lower than expected ridership has generated financial difficulties in these systems that has forced city authorities to introduce subsidies. In the case of Cali and Bogotá, these subsidies have been partly funded through a novel and interesting mechanism to be discussed further below.

Figure B.2: Vehicles in operation and passengers in Bucaramanga



Source: Gómez-Lobo (2020)

There where other difficulties related to these reforms[b] However, even without these additional problems, the structural issues commented here –an ambitious reform without subsidies and relatively short confined busways– would still have generated the demand shortfall observed in the SITM experiences. Note also that suppressing alternative modes (such as the old informal buses that still operated post-reform in some cities or paratransit services such as moto-taxis) may increase BRT ridership but decrease users' welfare. Users are revealing by their behavior that alternative modes are more attractive to them than the new BRT systems.

[a]This summary is based on Gómez-Lobo (2020).

[b]See for example, IADB (2015) and Diaz et al. (2018) for a review of the case of Cali.

The main lesson from the "gold standard" BRT experiences is that when they are built in dense corridors and are sufficiently extensive so that trunk speeds provide time savings that more than compensate for the added transfer costs, these systems can provide equivalent benefits to rail or subway investments. The case of Curitiba, Bogotá[18], Mexico City and Lima attest to the positive impacts of these systems.[19] Additional experiences, including Quito, Guayaquil, Leon and others, are reviewed in Hidalgo and Garaftieaux (2008).

However, for smaller cities care must be taken to ensure that users will benefit from the reform. This requires a careful analysis of how users' time costs will be affected by transfers. In addition, it must be recognized that in general it is not possible to modernize transit services without subsidies. The implicit use of fleet reductions and high capacity buses to reduce costs can lead to serious ex-post problems. Jara-Díaz and Gschwender (2009) show theoretically that when planning an optimal transport system without subsidies, bus frequencies will be too low and bus sizes too large, negatively affecting users' welfare.

5.4 Low cost interventions

What if there is no funding available for major MRT investments or to subsidize a modern BRT system? In that case, one alternative is to implement low-cost interventions. They are less ambitious but can be a very effective way to improve mobility.

One example is the construction of "open" bus priority infrastructure.[20] By this, we mean confined bus lanes that shield buses from the congestion caused by private vehicles. But, unlike their gold-standard counterpart, buses

[18]It is interesting to note that prior to the first phase of Transmilenio and during the first five years of its implementation, transit fares increased significantly in Bogotá (Ardila-Gomez, 2005). This helped to finance the higher operational costs of the new system without resorting to subsidies.

[19]Hidalgo et al. (2013); Carrigan et al. (2017); Paget-Seekins et al. (2015); Carrigan et al. (2017); Bel and Holst (2018); IADB (2015); Scholl et al. (2018); Martinez et al. (2021); World Bank Transport Global Practice (2020).

[20]These are sometimes referred to as "light-BRT" to distinguish them from the "gold standard" version reviewed in the last section.

enter and leave these corridors and continue their route in mixed traffic conditions without forcing passengers to make transfers. This alternative may be very attractive for smaller or medium size cities where relatively short trunk corridors make closed BRT type infrastructure unadvisable, as argued above. These investments can be undertaken without modernizing operators or their fleet, reducing the cost, complexity and political difficulties in implementing the plan.

Box 5.3 presents two examples of successful open corridor experiences. The first is the case of a medium size city in southern Chile and the second the case of Buenos Aires, a major metropolitan capital.

Box 5.3: Open corridors in Concepción (Chile) and Buenos Aires (Argentina)

Concepción is a medium size city (one million inhabitants) in southern Chile.[a] In 2002 operating contracts were tendered to better organize the bus system in the city. However, besides introducing a bus color pattern and route codes to help identify services, not much else changed in the transit system. A bus priority infrastructure plan was developed that did not require altering the network route structure, the fleet size or the industrial organization of operators.

The first segregated corridor was finished in 2005 and currently there are 22.2 kms of open confined busways (see picture above) and 16.5 kms of bus lanes. Buses enter and exit this infrastructure without the need for passengers to make transfers. There are plans to extend this network further with the construction of another 27 kms (of a plan of 93 additional kilometers) under a Public Private Partnership (PPP) arrangement (https://mtt.gob.cl/archivos/33206).

The higher speeds achieved by buses over this infrastructure (without the need of transfers) has made transit a more attractive travel mode in this city. This may explain why the modal share of public transport (including buses, one commuting train line and shared taxis) remains relatively high in Concepción (40% according to DGC (2024)). An indirect way to evaluate the impact of this infrastructure is to note that the number of buses in operation grew by 5.7% between 2010 and 2018, a trend contrary to the decline evidenced in most other major cities of the country.

Figure B.3: Open bus corridors in Concepción

Source: From "Corredor Concepción", by Soy Chile (2017), https://www.soychile.cl/Concepcion/Sociedad/2017/08/23/483276/Abrieron-el-corredor-de-transporte-publico-del-eje-21-de-Mayo-de-Concepcion.

The city of Buenos Aires (CABA, by its Spanish acronym), has a population of over 3 million, but it is part of the metropolitan area of Buenos Aires with over 13 million inhabitants. Since 2011, the city has constructed 7 open corridors totaling 62.5 kilometers of exclusive bus infrastructure (82 if the Matanzas corridor, located outside of CABA, is included). These were built without modifying the route configuration or changing the organization of operators. The fleet was not renovated but some articulated buses were introduced in some corridors.

Kamrowska-Zaluska (2017) reports that the corridors have reduced travel times by 20 to 40% on average, and up to 50% in some cases, without the cost of additional transfers. Warnes (2022) estimates the welfare impact of these investments considering heterogeneous workers and spatial sorting as a consequence of changing land rents and travel costs. He finds that both low-skilled as well as high-skilled workers were made better off on average, but high-skilled workers benefited more. However, these investments seem to have increased spatial segregation of workers within the city. This last issue points to the need of complementing mobility policies with land planning and housing policies within a wider urban development strategy.

Figure B.4: Open bus corridors in Buenos Aires

Source: From "Metrobus 9 de Julio" by Gobierno de la Ciudad de Buenos Aires (nd), https://buenosaires.gob.ar/caminando-la-ciudad/prioridad-peaton.

[a]Most of this summary is based on Gómez-Lobo and Barrientos (2018).

Even non-confined bus lanes may improve bus speeds, although by less than completely segregated bus priority infrastructure. These can be enforced through cameras with fines processed remotely, as is done in Santiago, Chile. Another and even less expensive alternative is to declare certain roads as bus-only streets at certain times of the day, or even declaring a small portion of a road –where there is a congestion bottleneck for example– for the exclusive use transit services. Enforcement through cameras improves the effectiveness of these options. Box 5.4 presents some examples from Chile.

Box 5.4: Bus lanes exclusive road use and camera enforcement: examples from Chile

There are a myriad of different alternatives to improve mobility with low-cost or even limited tactical interventions. Bus lanes are one example. In this case there is no physical segregation from other vehicles, except perhaps by paint or road studs. These will be less effective in increasing bus speeds since other vehicles can enter these lanes. This can be controlled through cameras but, as they are usually built in the right line of roads, they must allow for other vehicles to enter to turn right at intersections. Santiago has 304 kilometers of such infrastructure and many of the 476 traffic enforcement cameras are used to control these bus lanes (DTPM, 2022).

Figure B.5: Bus priority lane, Santiago

Source: From "Solo Bus" by MTT (2020), https://www.mtt.gob.cl/archivos/27452.

Another alternative used in Santiago is to restrict the use of certain main arteries in the central part of the city for exclusive use by buses and taxis. Residents and others can use them but must leave or enter at the closest possible opportunity. Any non-transit vehicle passing more than two consecutive enforcement cameras will be fined. In Santiago there are 29 kilometers of such exclusive two-lane streets. Some operate from 7 a.m. to 9 p.m. while others only during peak hours. At other times, and on non labor days, all vehicles can use them.

Figure B.6: Exclusive streets used by public transport during peak hours, Santiago

Source: From "Vía solo Transporte Público" by Practica Test (nd), https://practicatest.cl/blog/normativa-de-transito/pistas-solo-bus-santiago.

Another option is declare just a few blocks of certain streets for exclusive use by public transport. The idea is to overcome bottlenecks in key avenues to increase transit vehicle speeds. An example (see photo below) is Temuco, a relatively small regional capital in southern Chile (350,000 inhabitants) where 7 to 8 blocks in each of two central streets are designated for exclusive use by buses during labor days (between 7 a.m. and 8 p.m.). Once again, this policy is enforced through cameras.

Figure B.7: Exclusive bus only street segments, Temuco

Source: From "Vías Exclusivas", by Temuco Te Mueve (nd), https://www.temucotemueve.cl/ttm/?page_id=27.

As previously mentioned, there is theoretical research showing the advantages of dedicating road space for public transport use (Basso and Silva, 2014). González and Silva (2024) leverage over 90 million observations of bus GPS data for Santiago and estimate that the segregated corridors increase peak period bus speeds by 20%.[21] This is a significant figure and comparable to the effects of the London congestion charging scheme on traffic speeds. Interestingly, this study also shows that the benefit of bus only streets (enforced through cameras) are similar to the segregated bus lanes. However, for the case of non-segregated curbside bus lanes they do not find any speed gains, even when enforced through cameras.

With these low cost interventions, users not only gain in terms of in-vehicle time, but higher bus speeds allow planners to set higher frequencies for a given bus fleet. They also allow operators to maintain better scheduling between buses. Adherence to schedules and reliability of arrival times are highly valued by users, since it allows for better trip planning and reduces waiting times. Investments in fleet management technology can improve reliability. The technology is also available to provide users with real-time

[21] This figure implies a reduction of about 17% in travel times, lower than the 20-40% reduction estimated for the Buenos Aires corridors discussed in Box 5.3.

information on arrival times, either at bus stops or through mobile phone applications. Both of these low-cost interventions improve service quality.

Thus, even if nothing else is undertaken in a reform (off-board payment, fleet renewal, formalization of operators, etc.), investing in bus priority infrastructure, fleet management technology and real-time arrival information systems, can reduce waiting and in-vehicle time costs and thus increase users' welfare as shown by the following equation:

$$\Uparrow W = \theta \cdot U - c_{t_a} - \downarrow c_{t_w} - \Downarrow c_{t_v} - c_f \tag{4}$$

Low cost mobility investments are not limited to transit. Traffic management strategies improve mobility for both public and private transport. These can be as simple as making some streets reversible one-way roads at peak times or more sophisticated; for example, installing intelligent traffic signals. In some LAC cities, remote control and real-time optimization of traffic lights is undertaken in especially designed control centers using closed-circuit television cameras (CCTV), automatic traffic counting machines, information panels, as well as other data gathering tools and communication channels with users. Examples include the *Unidad Operativa de Control de Tránsito* (UOCT) in major cities of Chile. In the case of Santiago, the UOCT manages traffic lights at 3.048 intersections, has 260 CCTV cameras, 17 variable information panels, 60 traffic counting stations, Bluetooth technology in 5 routes to monitors travel times and, since 2018, drones to detect incidents (accidents) and monitor the state of traffic congestion in the city.[22] Unfortunately, not much research has been undertaken in the region on the impact of these investments.

5.5 Aerial cable-car transit

A special mention should be made of another LAC innovation: the use of cable-cars in integrated mass transport systems. Although their capacity is low (2,000 to 4,000 passengers per hour per direction) and are relatively slow (between 10-20 km/h) compared to other modes, they are a suitable option in certain situations. For example, short to medium distances (up to 5 km)[23]

[22] https://loslagos.transporteinforma.cl/conoce-uoct/uoct-en-el-pais/.

[23] Although one line in Mexico City has over 10 km in length.

over terrain with important elevation differences (as a hill or mountain side) or where other obstacles (e.g., ravine, river) are present.

Since the opening of the first line in Medellín in 2004, these systems have grown in importance, with operational transit lines in Medellín, La Paz, Mexico City, Bogotá, Manizales, Pereira, Cali, Guayaquil, Caracas and Santo Domingo.[24] See Table 7.

Table 7: Selected examples of cable-car transit lines in LAC

City	Number of lines	Total length (km)	Average length per line (km)	Investment (US$ million per km)	Speed range (km/h)	Capacity range (phpdt)
Bogotá	1	3.25	3.25	22.7	12.6-19.8	3,600
Cali	1	2.79	2.79	12.5	16.7	3,000
La Paz	10	30.5	3.05	27.2	18.0	29.000
Manizales	2	2.58	1.3	19.3	18.0	1.400
Medellín	6	14.62	2.42	17.3	13.5-16.8	1,200 - 4,000
Mexico City MA	2	13.1	6.6	19.9[a]	15.5-21.6	3,000[a]
Santo Domingo	1	5	5	13.8	17.2	3,000

Source: Bogotá: Estadísticas de oferta y demanda del Sistema Integrado de Transporte Público-SITP-marzo 2024 (www.transmilenio.gov.co) except for capacity and investment which was calculated based on data from World Bank Group (2020). Medellín: Memoría de Sostenibilidad 2022 (www.metrodemedellin.gov.co) except for investment which was calculated based on data from World Bank Group (2020). Mexico City (Metropolitan Area): mexicable.com and World Bank Group (2020) [a] data for Line 1 only. All other: World Bank Group (2020). Phpdt stands peak-hour per direction traffic and its range is between the lowest and highest capacity line. Speed range is minimum and maximum among different lines or within a line.

Cardona-Urrea et al. (2024) review the academic literature and note that cable-car lines reduced travel times by 20% (22 minutes) in Bogotá, 7.7% in Medellín, 3.4% in Manizales and 22% in La Paz.[25] There is also evidence of mode switching from private transport to this transit mode. Furthermore, there is also evidence that these investments help renovate neighborhoods, reduce crime and provide other external benefits.

[24] There are some other cable-cars in operation in LAC but geared to tourism. Several lines were built in Rio de Janeiro, but have since ceased operation due to financial issues.

[25] In La Paz, frequent users of *Mi Teleferico* saved 70 minute of commute time per day according to Martinez et al. (2018).

This innovative transit investment can therefore improve urban mobility. However, it must be borne in mind that they are efficient only in particular topological circumstances and will most probably remain a niche mode in most cities. For example, until 2015, in La Paz, the *Mi Teleférico* modal share was less than 4% (Martinez et al., 2018). Also, as noted by Cardona-Urrea et al. (2024), it is important to assure that cable-car services have fare integration with other transit modes. Travel time savings may not be sufficient to compete with the flexibility provided by alternative paratransit or bus services, as the case of Manizales seems to show. In the case of Rio de Janeiro, the placement of stations at the top of hills increased access costs that more than outweighed the time savings benefit for many potential users (Cardona-Urrea et al., 2024). Once again, this points to the fundamental importance of understanding the determinants of passengers' welfare (as summarized by equation [1]) for their travel choice behavior.

5.6 Mass transit and property values

Besides the direct benefits to users in terms of travel times, lower environmental impacts and economic benefits, there is also evidence that mass transit investments increase property values in their area of influence.

For example, Cárdenas et al. (2023) estimate that the mere announcement of the construction of the first metro line (Line 1) in Bogotá increased property values by 5.2% and 10.5% for apartments within 1 kilometer and 1.5 kilometers of a future station, respectively. The equivalent figures for housing prices are 7.1% and 6.5%. These results are interesting considering that this line is overlaid on an existing Transmilenio BRT corridor that had already increased property values, as will be discussed shortly.

Similar anticipatory effects on property values are reported by Agostini and Palmucci (2008) for metro expansion announcements in Santiago, Chile. In the case of Buenos Aires, Rosanovich and Di Giovambattista (2019) find non-linear effects of property values to the proximity to a subway station, with a negative effect (-5%) within 200 meters and a positive impact (3.6%) between 200 and 600 meters.

Vergel-Tovar et al. (2024) also estimate the impact of the Bogotá metro announcement in real estate development projects. They found that new building regulations and projects within 800 meters of a station had higher prices (7.2% to 8.1%) compared to units outside this area of influence. They also found out that an increase in the supply of new units in the treatment area. According to these authors, the recent announcement of a second metro line in Bogotá has not yet caused a change in the real estate market.

Similar property price impacts have been measured for BRT systems. Controlling for other local characteristics, Rodriguez and Targa (2004) found that in Bogotá a 5 minute longer walk to a BRT station reduced property values between 6.8% and 9.3%. Munoz-Raskin (2010) finds similar results. However, since both of these studies use cross-sectional data, attributing the impact only to the BRT network may be suspect. Nevertheless, studies using more robust methodologies have found similar or even higher impacts in Bogotá (Rodríguez and Mojica, 2009).[26] Guzman et al. (2021) found heterogeneous effects of the BRT network on property values in Bogotá, increasing for lower-income neighborhoods but neutral or negative for middle and high-income neighborhoods. Rodriguez et al. (2016) found an increase in property valuer around the Quito trolley BRT stations.

For other mass transit technologies there is less evidence available. Vergel-Tovar et al. (2023) analyze the case of Medellín where they found that Line A of the subway, complemented by a new BRT line, increased property values by 4% to 14%, the light rail Ayacucho project generated a property value premium of 4% while the oldest cable-car in the city by 2%. Martinez and Winters (2020) estimate that property values increase by 33% per kilometer the closer they are to La Paz's Silver Line cable-car. In Cuenca, Ecuador, a tram project seems to have reduced nearby residential rental values while increasing commercial rental values (Hermida et al., 2018). However, these last results are for a period when the project was under construction, and so may be influenced by the inconvenience of the construction works.

In sum, there is ample evidence that mass transit projects generate a real estate price premium. Several question arise with respect to this phenomenon. First, should these premiums be considered as additional benefits of these projects? Second, could these premiums be used as an indirect way of measuring the benefits of a certain project when other conventional tools

[26]However, Perdomo (2011) does not find a significant impact.

are unavailable?[27]

As to the first question, the answer is generally no, as it would imply double counting of benefits. Property prices usually increase because individuals and firms are willing to pay more for better access to a fast and reliable transport mode. These last benefits will be conventionally measured by the time cost savings of passengers at the project appraisal stage. The exception would be when there are inefficiencies in real estate markets (due to non-optimal building and land-planning restrictions, for example) or some type of agglomeration economy for commercial development (Venables, 2016).

With respect to the second question, the answer is also no, since it would entail underestimating the benefits of a project. As discussed in Litman (2024), not all benefits of a transit investment are capitalized in land or property values. Table 8 reproduces the table by Litman (2024) showing which benefits are likely to be capitalized and which are not. Any benefit or cost reduction accruing to individuals not involved in the affected property market will most likely not be incorporated into prices. Therefore, using some property up-lift parameter to estimate the benefits of a mass rapid transit investment in lieu of a more conventional approach will most probably underestimate these benefits.

There is another dimension in which property premiums may be relevant. They could be tapped to help fund part of a mass transit capital investment or operational costs. For example, property taxes could be increased or a special charge could be introduced to capture some of the benefits accruing to property owners from the new infrastructure. The type and design of these value capture mechanisms goes beyond the scope of this document.

[27] Another issue is the social impact of the increase in property values near mass transit infrastructure. Rising property values may displace poorer households from the most convenient residential locations in the city. As discussed in Box 5.3, this may have occurred in Buenos Aires where there is evidence that the bus corridors increased spatial segregation.

Table 8: Transit benefits capitalized in property values

Benefits	Capitalized in property values
User benefits	Yes
Congestion reduction	Direct yes, indirect no
Facility cost savings	Direct yes, indirect no
Consumer savings	Direct yes, indirect no
Transport diversity	Direct yes, indirect no
Road safety	Mostly not
Environmental quality	Mostly not
Efficient land use	Some
Economic development	Some
Community cohesion	Some
Public health	Possibly

Source: Litman (2024), Table 36.

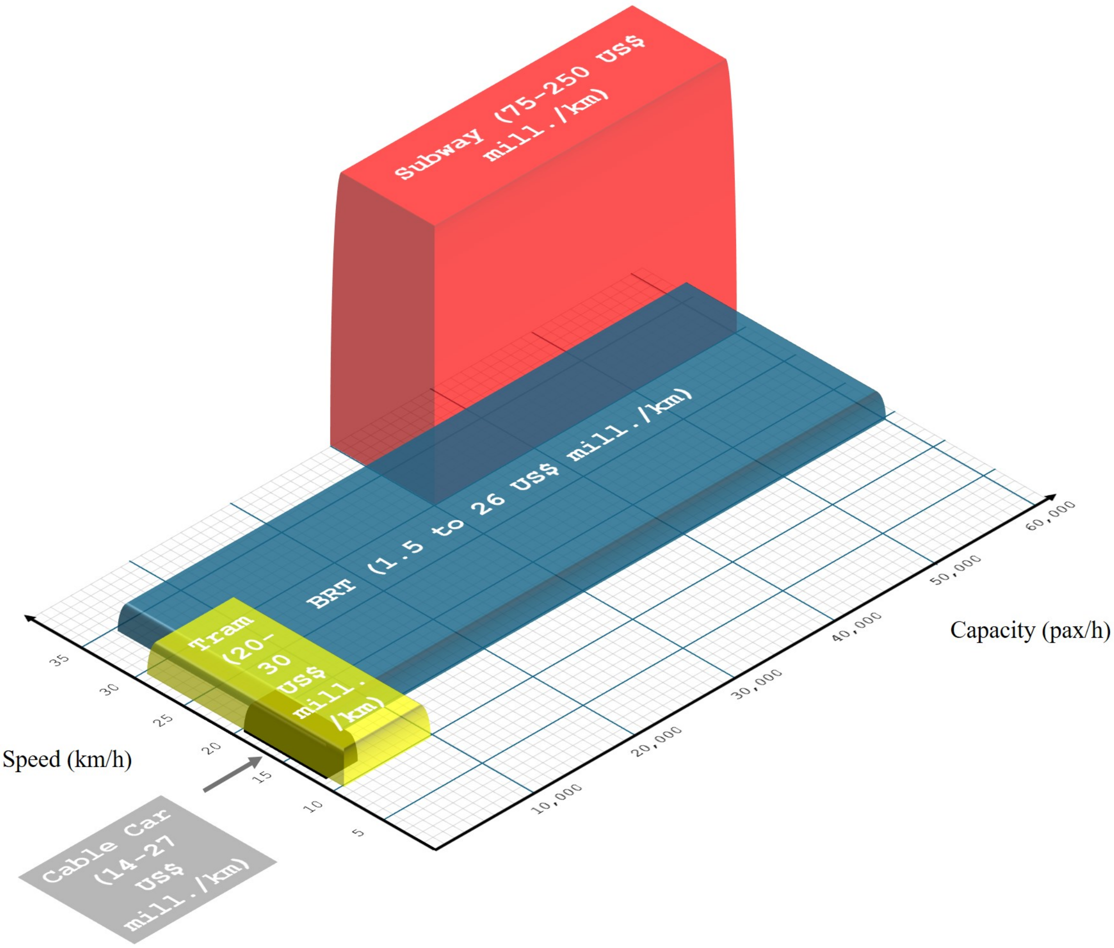
5.7 Summary of mass transit investments

Figure 1 presents a summary of the cost, speed and capacity of the alternative mass transit investments discussed above. Choosing among these options will depend on available capital funding, available operational subsidies, the city size, the quality and formalization of existing operators, among many other considerations.[28]

The axes represent the range of capacity and speed for each type of technology. The height of each prism represents the maximum investment cost per kilometer (in millions of US dollars).

[28] Navas et al. (2023) also presents speed and capacity data for different mass transit investments.

Figure 1: Capacity range, speed range and cost per kilometer of different mass transit technologies



6 Regulations, taxes and subsidies

The promotion of a "win-win-win" strategy to improve mobility can also be undertaken through regulations, be it pricing or "command and control" type regulations. These usually work by altering the financial cost of using different modes. To illustrate this point, let's assume that initially the average user obtains a higher welfare from using private transport compared to public transport:

$$
\begin{aligned}
W^{pr} &> W^{pub} \\
\theta^{pr} \cdot U - c^{pr}_{t_a} - c^{pr}_{t_w} - c^{pr}_{t_v} - c^{pr}_{f} &> \theta^{pub} \cdot U - c^{pub}_{t_a} - c^{pub}_{t_w} - c^{pub}_{t_v} - c^{pub}_{f}
\end{aligned}
$$

The authorities wishing to promote public transport can alter the time cost component of this comparison through infrastructure investments, as reviewed in the last section, or change the financial cost of using each mode.

A fuel tax, parking tax or congestion charge on private automobiles will increase the financial costs of using this mode (c^{pr}_f), tilting the balance of the above inequality for some users in favor of public transport. Likewise, a transit subsidy will reduce the financial cost of using this mode (c^{pub}_f) attracting passengers from alternative modes. Other policies, such as a license plate driving restriction are equivalent to a tax, given that the inability to drive on a certain day is akin to a infinite price for that mode.[29]

6.1 License plate driving restrictions

Driving restrictions –usually related to license plate numbers– are very common in LAC as in other parts of the world. Examples include the *Pico y Placa* in most medium and large cities of Colombia, *Hoy no circula* in Mexico City, and similar policies in Sao Paulo, Quito, and La Paz. The popularity of these regulations stems from their simplicity, ease of understanding by the general public and their perceived "fairness" in that all drivers, rich and poor, are affected.

However, there is abundant evidence that these policies are counterproductive (Eskeland and Feyzioglu, 1997; Davis, 2008; Gallego et al., 2013). They may reduce traffic congestion in the short term, but in the medium term they promote the purchase additional vehicles, usually cheaper, older and more polluting. Thus, the effectiveness of this policy to tackle congestion declines with time, while at the same time exacerbating negative environmen-

[29]Or the price of purchasing and maintaining an additional vehicle to circumvent the restriction, as will be discussed below.

tal externalities.

The seemingly "fair" characteristic of driving restrictions is also questionable. Richer households tend to have more cars in the first place. They can coordinate the use these vehicles to circumvent the restriction. They also have more resources to purchase an additional vehicle if needed. Therefore, in practice, driving restrictions affect middle to lower income households more than richer households.

Another negative consequence of driving restrictions is that, when they work, they repress both high-valued as well as medium or low-valued trips. Why does this matter? Let's use a hypothetical example. First, take the case of a physical therapist who must visit numerous patients throughout the city every day. For her, being able to use a private vehicle to make these house calls (transporting the required equipment) is highly valued. This person would be willing to pay a significant price to have the flexibility of using her car everyday. Second, suppose another person uses his car to commute to work but is almost indifferent to using public transport (lives near a subway station, for example). This person would not be willing to pay much for the privilege to drive to work and so his car trip is of little value. If charged, he would switch to transit. A driving restriction suppresses both types of individuals; it does not discriminate between high and low-valued trips.

This is an inefficient way to tackle congestion. In our example, the day the physical therapist cannot drive, she would be willing to pay someone with a low valuation to "purchase" their driving rights that day. But there is no mechanism for this transaction to take place. As will be reported below, empirical estimates for the case of Bogotá suggest that this inefficiency is a major economic cost of this policy.

There are cases when driving restrictions can be effective, but not to improve mobility; for example, a vintage based driving restriction. This was the case in Santiago, where in 1992 a two-digit daily restriction was introduced during the winter months to reduce particulate matter pollution. Newer models with a catalytic converter where exempted. Barahona et al. (2019) estimate that this policy accelerated fleet renewal and overall was welfare enhancing.[30] Unfortunately, vintage exemptions can help reduce emissions but not congestion.

An interesting innovation is the recent experience of Cali and Bogotá. In these two cities, a charge was introduced to exempt a vehicle from the driving restriction. Although the main motivation was to raise revenue to fund their transit systems, they are nonetheless a form of congestion charge. We will present details of these experiences further below.

6.2 Congestion charge

Economists have long advocated the use of pricing instruments to tackle congestion. The idea is to charge vehicles that enter a certain area of a city, often called a congestion charge or congestion toll. By increasing the financial costs to private drivers, some will opt to use another mode (e.g., transit), reschedule their trip or not make the trip at all.

Note that this mechanism does not generate incentives to purchase additional vehicles –all vehicles pay the toll– and so it is more effective and efficient than a driving restriction. It also has two other attractive properties. First, only trips that are valued less than the charge will be suppressed. Following our example above, the physical therapist would be willing to pay and drive every day, while the low-value driver will opt to use public transport (every day). Thus, a congestion charge is economically efficient. Second, it raises revenue that can potentially be channeled to infrastructure projects, improve transit quality or reduce transit fares.

Globally, only a handful of cities have implemented such a scheme, including Singapore, London, Stockholm, Gothenburg, and Milan; New York City has announced plans to introduce a congestion toll soon. All these experiences are from the developed world. To date, no such scheme has been introduced in a LAC city.[31] However, the introduction of an exemption charge in the driving restriction scheme in Cali and Bogotá, noted above, is

[30] See also Basso et al. (2021).

[31] In Santiago there is an extensive network of tolled urban highways built and operated under PPP contracts. Since there are non-tolled alternatives to enter the most congested parts of the city, it is unclear whether these tolls have any measurable impact on congestion.

a form of congestion toll.

Box 6.1 presents details of Bogotá's driving restriction exemption payment introduced in September 2020. A few years earlier, Cali had introduced a similar exemption payment. The motivation for these reforms was to raise revenues to cover the mounting financial deficit of their transit systems. Probably without realizing it, they had also introduced a type of congestion charge originally proposed by Daganzo (2000) and denominated as a "taking turns" congestion charge.

Box 6.1: Driving restriction exemption payment in Bogotá

Bogotá is one of the most congested cities of the world.[a] In August 1998 a license plate driving restriction was introduced during working days that applied to 20% of private and commercial vehicles from 7:00 a.m. to 9:00 a.m. and 5:30 p.m. to 7:30 p.m.. This scheme, named *Pico y Placa*, was gradually expanded to include 50% of the vehicles from 6:00 a.m. to 8:30 p.m. and 3:00 p.m. to 7:30 p.m. The restriction was based on an odd-even policy of the last digit of the vehicles license plate number. In January 2023 it was changed to a sequential number restriction (1-5 one day and 6-0 the other day) and the hourly coverage was expanded from 6:00 a.m. to 9:00 p.m.[b]

As a direct result of the financial difficulties faced by the SITM reforms in intermediate cities of Colombia (see Box 5.2) and the SITP reform in Bogotá, the 2014-2018 National Development Plan Law (Law 1753, July 2015) included several provisions for the funding of transit subsidies. Among other things, article 33 of this law authorizes local, metropolitan and regional authorities to establish novel revenue sources, including: a) parking fees, b) congestion and environmental charges and c) value capture instruments.

After this legal change, the Municipality of Cali approved an exemption charge to their *Pico y Placa* driving restriction scheme which came into effect in January 2017. Bogotá introduced a similar exemption charge in September 2020 and called it *Pico y Placa Solidario*.

The charge is calculated as:[c]

$$VPP = VBP_i \cdot A \cdot M \cdot B$$

where VPP is the total value of the permit, VBP_i is the base value depending on whether its a daily, monthly or semester pass, A is an uplift factor based on the value of the vehicle, M is an uplift factor depending on the municipality where the vehicle is registered and B is an uplift factor that depends on vehicle emissions. These values, converted to US dollars are:[d]

VBP_i	US$
Day	16
Month	130
Semester	648

Vehicle value (US$)	A
Under $13,793	1.00
Between $13,793 and $31,033	1.25
Above $31,033	1.50

Municipality of registration	M
Bogotá	1.00
Other	1.20

B varies between 1.00 and 1.20 depending on the fuel type, age and engine size (the full table can be consulted in Resolución 23.850).

An interesting feature of the *Pico y Placa Solidario* is that the first time a (non-commercial) user wants to purchase an exemption permit, he or she must first undertake a virtual "Sensibility Module" and pass a test. The module provides information on the scheme and on the social, environmental and safety impact of private vehicle use.

[a]This first paragraph is based on Montero et al. (2023).

[b]Note that the change from an odd-even to a sequential number restriction will have an impact on congestion as some households that had purchased an additional vehicle based on the odd-even policy may no longer be able to circumvent the restriction on the sequential policy. For example, if a household has two vehicles with the last digits of their respective license plate being 2 and 3. This points to an interesting solution to avoid the incentives to purchase additional vehicles under a driving restriction: periodically change the sequence of numbers that are restricted each day.

[c]Resolución 23.850 de 2024 Secretaría Distrital de Movilidad, Alcaldía Mayor de Bogotá, 27 de febrero 2024.

[d]The average daily exchange rate between March and June 2024 of $ 3,919.22 per US$ was used (www.banrep.gov.co).

Daganzo (2000) recognizes that one of the main obstacles to introduce a congestion charge is that drivers perceive the financial cost of such a scheme but not the benefits from the use of the toll revenues to provide other goods and services. To create a direct link between payments and benefits, he proposed a congestion toll where drivers are not charged everyday, only some days of the week (drivers "take turns" in paying the toll). Thus, when a particular driver does not have to pay, they can travel free and with less congestion. The time savings during those free days should be perceived as a direct benefit of the charge faced in the non-free days. Daganzo (2000) conjectures that this scheme may even be beneficial to everyone (Pareto optimal) facilitating the introduction of congestion charging.

A driving restriction with an exemption payment is equivalent to Daganzo's idea. The days a vehicle is restricted, the driver can either pay or make other arrangements for his/her trip. But the days it is not restricted, the driver can make the trip free and in less congested conditions. When the number of digits restricted per day reaches ten, then this scheme converges to a classical congestion charge.

Since the exemption payment was introduced in Cali and Bogotá after the driving restriction was in place, the potential use of this instrument to tackle congestion will be realized when the driving restrictions are tightened; by either increasing the number of daily digits restricted, expanding the daily hours it applies, or both.[32] However, for cities that do not have a driving

[32]This was the case in Bogotá. In January 2023 the time coverage of the driving

restriction or those wishing to increase the daily digits restricted, introducing an exemption payment provides a promising way forward.

The scheme in Bogotá has already improved welfare. Montero et al. (2023) estimate the benefits of introducing the exemption payment in this city at US$ 222 million per year. A large part of these benefits are attributed to the flexibility to undertake high-valued trips that were previously restricted. Following the example of the previous section, the physical therapist that values highly the possibility of driving everyday can now pay to avoid the restriction. They also show that middle-income individuals gain the most while high-income individuals lose from the reform.

Basso et al. (2021) show that for Santiago, introducing a driving restriction with an exemption payment (and also with vintage exemptions) is not Pareto optimal (does not benefit every social group) as conjectured by Daganzo (2000), unless revenues are used to lower transit fares or increase transit quality. Despite this result, it is probably a more politically palatable alternative to a classical congestion charge, especially if the toll is also linked to a vehicle's value, as in Bogotá.

An important pricing instrument that is often overlooked is a parking tax and other parking policies (Rivas et al., 2019). Since driving requires a place to park, a parking fee will be equivalent to a congestion charge. It may be easier to increase the price of parking than to introduce a congestion charge. In Colombia, the 2014-2018 National Development Plan Law (Law 1753, July 2015, see Box 6.1) authorized cities to introduce a parking tax to fund their mass transit systems. An indirect way to achieve the same result is to limit parking availability. Reforms in several Mexican and Brazilian cities have removed minimum parking requirements in their building codes for off-street parking (Dana and MacKenzie, 2023; Ríos et al., 2013).[33] Others have eliminated on-street parking and replaced them with bicycle lanes, as in Santiago. This policy, along with other measures, was decisive to Santiago earning the 2017 Sustainable City Award.[34] Unfortunately, not much

restriction was expanded from an initial schedule of 6:00 a.m. to 8:30 a.m. and 3:00 p.m. to 7:30 p.m. to 6:00 a.m. to 9:00 p.m. As far as we are aware, the effect of this expansion on congestion has not been researched.

[33] See also https://itdp.org/2019/01/31/rio-joins-parking-reform-leaders/.

[34] https://www.staward.org/past-winners/2017-santiago-chile-8pech.

research has been undertaken on the impact of these and other parking policies on mobility. However, they represent a promising policy alternative to congestion charging.

6.3 Subsidies

Rather than increase the cost of private transport, another policy option is to decrease the price of public transport. In fact, the optimal policy combination is to use both, a charge to private vehicles and a transit subsidy, as will be discussed below.[35]

Transit subsidies are ubiquitous in LAC. Rivas et al. (2020) estimate that these subsidies represent on average 0.23% of GDP in the region, with wide variation by country and city. At the high end of this range are Chile (0.4%) and Argentina (0.8%). The share of operating costs covered by these subsidies in 2019 ranged from 26% in Bogotá to 69% in Buenos Aires (Rivas et al., 2020). Formal transit systems in Mexico City, Buenos Aires, Panama City, Santiago, Bogotá, Sao Paulo, Montevideo and many BRT systems in medium-sized cities of Colombia are subsidized (Basso and Silva, 2014; Gómez-Lobo, 2020; Rivas et al., 2020). In some cases, subsidies are not transparent and operate through fuel subsidies and other, often opaque, transfer mechanisms.

Are these subsidies justified? There are three main arguments in favor of transit subsidies. Two are related to economic efficiency and the third to social or affordability issues. We begin with the efficiency arguments.

When private transport generates negative impacts (congestion, pollution emissions, accidents) and it is not possible to correct these externalities through an appropriate tax or congestion toll, a second-best policy is to reduce the price of a substitute service such as transit (Small and Verhoef, 2007). This will induce some travelers to switch from private transport to

[35]For a more thorough discussion of transit pricing, taxes and subsidy issues in LAC see Gómez-Lobo and Serebrisky (2023). While transit subsidies are often discussed, less attention is paid to hidden subsidies for private vehicle travel. The way many urban areas fund roads does not reflect the actual social cost imposed by this travel mode. This goes back to our previous discussion on the justification for congestion tolls and perhaps other charges.

public transport, reducing the negative indirect impacts of the first mode. The optimal subsidy will depend on the demand reaction of private trips to transit fares (technically the diversion ratio between both modes). Empirical studies indicate that a very low but positive diversion ratio is enough to justify a significant transit subsidy.

When an optimal charge (equal to the negative social impacts of private vehicle use) is introduced, the second-best argument described above does not apply. However, another efficiency reason to subsidize transit remains. This has to do with what is called the Mohring effect (see the appendix). Higher demand allows for a denser route network and higher frequency of service, reducing access and waiting times. Thus, new passengers generate a positive consumption externality on already existing passengers who benefit from the resulting higher frequency and service coverage. In essence, total costs, including users' time cost, decrease as transit demand increases. This justifies an optimal subsidy to attract more demand to the transit system.

How important are these efficiency arguments in practice? Parry and Small (2009) estimate that they justify large transit subsidies (over 50% of operating costs) using data from Los Angeles, Washington, D.C. and London. Similar studies in LAC confirm the same results. Recently, Rizzi et al. (2023) estimate that the economic returns of transit subsidies in Asunción, Paraguay, reach 130%-160%. Basso and Silva (2014) estimate optimal bus subsidies for Santiago, Chile, of 55% of operational costs, close to their current level.[36] Parry and Timilsina (2010) estimate an optimal transit subsidy of 50% for Mexico City, also close to its real level at the time of their research. See also Gómez-Gélvez and Mojica (2022) for the case of Bogotá. In this last study, the authors place particular emphasis on the detrimental effects of crowding in buses. If system planners do not match the additional demand generated by subsidies with a proportional increase in transit supply, the consequent crowding costs more than compensate for the positive Mohring and externality effects.[37]

In summary, there are various efficiency reasons to subsidize urban public

[36] See Tirachini and Proost (2021) for a more recent estimate using a general equilibrium model including other taxes and income distribution weights.

[37] On the perceived cost for users of in-vehicle crowding see also Batarce et al. (2015) for the case of Santiago.

transport.[38] There are also social or distributive reasons to subsidize public transport (Serebrisky et al., 2007). Transit expenditure in LAC is a necessary good (Gandelman et al., 2019). This implies that low-income households spend a higher proportion of their disposable income on this service compared to high-income households. As a result, in principle, using subsidies to lower transit fares over the board should be well targeted, since in relative terms low-income individuals benefit more.

However, the effectiveness of this policy will be compromised if subsidies lead to productive inefficiency. This risk is higher when resources are transferred directly to operators (supply-side subsidies); knowing that cost increases will be covered by subsidies, operators may have reduced incentives to contain costs. Subsidy resources will then not pass-through completely to passengers. There is evidence that this has been the case in other regions of the world (De Borger et al., 2002) but scant research has been undertake on this issue in LAC.

To avoid this last problem, fares for passengers can be reduced without altering operators' revenues. An example of this last case is the use of fare stabilization funds in formal systems. Operators are paid according to the conditions set in their contracts (technical fare) and users pay the public fare. If fare revenue is insufficient to cover payments to operators, either public fares are increased or the authorities cover the shortfall by injecting subsidies into the fund. In this case, operators are paid the same irrespective of the subsidy amount and thus incentives to contain costs are not affected.

Another alternative are demand-side subsidies –where resources are transferred directly to users. The performance of demand-side subsidies will depend on institutional factors. The *Vale Transport* scheme in Brazil is a case in point. This is an employer paid voucher subsidy scheme whereby firms have to pay the commuting transit expenditure of their workers. Firms can deduct up to 6% of the worker's wage to fund these vouchers. This may provide

[38]Besides the second-best argument and the Mohring effect, there are other possible efficiency arguments in favor of transit subsidies. Although not in LAC, Franklin (2018) undertakes a randomized control trial using transit subsidies for vulnerable poor adults in Addis Ababa, Ethiopia, and finds that individuals who received the subsidy had a higher probability of finding permanent employment (and of better quality) than the control group. Thus, subsidies can improve labor market matching and increase productivity.

some targeting benefits since only low-wage earners –whose transit expenditure is above this 6% threshold– will be interested in taking up the benefit. However, the distributive performance of the scheme is suspect since it only benefits relatively richer formal sector workers rather than poorer individuals who work in the informal sector (Gómez-Lobo et al., 2022a). Nonetheless, it must be noted that from a second-best efficiency point of view, targeting the subsidy to middle-income workers may be optimal if the have a higher diversion ratio compared to poorer workers who may not have a choice of using a private travel mode.

If resources are limited and the objective is to target poorer individuals, a means-tested demand subsidy is an option. In a transit context this has been introduced in Buenos Aires and Bogotá. Box 6.2 presents details of the Bogotá experience. To implement a means-tested subsidy an instrument must be available in the welfare system to determine the socioeconomic condition of households.

Box 6.2: Means-tested transit subsidy in Bogotá

In Bogotá, Colombia, a novel means-tested transit subsidy was introduced in 2014.[a] It gave beneficiaries a 40% fare discount for 21 trips per month. To qualify for the benefit, an individual must be at least 16 years of age, must not receive another transit subsidy (e.g., elderly, or disabled fare discount), must not have made fraudulent use of any prior benefit in the system and must be registered in the SISBEN social security database with a score between 0 and 40 points. The SISBEN database is the administrative instrument used in Colombia to target social benefits.

Due to budgetary considerations several changes were introduced to the scheme since its inception, including the number of monthly trips subsidized, the percentage of the fare discount and the SISBEN cutoff threshold to qualify for the benefit. Currently, the subsidy is close to 15% of the fare for trunk services and 18% for feeder (zonal) services.[b] The SISBEN threshold is now 30.56.

To implement the subsidy, a smartcard payment technology –that could keep count of the number of trips made by each beneficiary– was needed. This was possible in Bogotá since prior reforms (Transmilenio in 2000 and SITP in 2012) had introduced an electronic payment card throughout the transit system. This card, called Tullave (literally "your key") can be personalised; that is, register the user's personal information (name and identification number). This capability is crucial to discourage fraudulent use of the subsidy.

Veeduría Distrital (2018) estimates that the subsidy benefits lower income individuals and increases accessibility for this group of users. A similar conclusion is reached by Guzman and Oviedo (2018) who find that the policy is progressive and improves accessibility for those receiving the benefit. Rodriguez et al. (2016) analyze the travel behavior and labor market outcomes of beneficiaries. They find that individuals with the subsidy increased their monthly trips by 56% (about 8 additional trips per month and 2 transfers) compared to non-beneficiaries. They also find that the subsidy increased hourly earnings of informal workers.

[a]This summary is based on Gómez-Lobo et al. (2022a).

[b]Calculated based on the information presented in https://www.transmilenio.gov.co/preguntas-frecuentes/96/tarifas/. Last accessed July 29, 2024.

In summary, transit subsidies are justified not only for social or distributive reasons but also for economic efficiency reasons. However, care must be taken in the design of these policies to avoid generating productive inefficiencies that reduce their effectiveness. Although a universal transit subsidy will generally benefit low-income individuals more, the social impact of the subsidy can be boosted by actively targeting resources to the most needy.

7 Other policies

There is a range of other pricing policies that help to improve urban mobility that we will not discuss in any detail. One example is the use of fuel taxes to curb congestion and environmental externalities. However, these taxes are generally introduced as a revenue generating tool, not as a policy to improve mobility. Although they provide benefits by discouraging motorized private transport, they are not suitable to reduce congestion. This is because they are applied at a national level and thus do not discriminate by city or area were congestion is most severe, nor do they discriminate by time of use of a vehicle. Ideally, a congestion related tax should be applied in the places and times that congestion is most problematic. In some countries, there are fuel subsidies rather than taxes. These policies promote private car use and are therefore counterproductive as far as congestion and other negative externalities are concerned.

There are two other areas that we have not discussed. One is the promotion of active mobility (walking and cycling) usually related to investments in infrastructure to facilitate these modes. Despite their positive impact and the need to encourage these travel alternatives, in the most optimistic scenario they will probably not account for a large share of commuting trips in major LAC cities. However, even a modal share of 5%-10% could have a non-negligible effect on congestion and significantly improve mobility.

The other topic is urban logistics. The need to distribute goods around a city – either to supply firms and commerce or to deliver them directly to households as ecommerce expands– has an important impact on congestion. Public policies in this area include the regulation of permitted distribution times in central parts of the city and very tactical infrastructure investments (e.g., parking bays for logistic vehicles). Policies to promote efficient operations through more formal and modern logistical firms will also contribute to reduce the impact of these activities. The present document is focused on passenger travel so we do not delve into this issue. For a review of the literature see Büyüközkan and Öykü Ilıcak (2022).

8 Conclusions

Mobility is crucial for the well-being of urban citizens. It is also important for labor productivity and economic development. As stated in the beginning of this document, improving urban mobility is akin to a free-trade agreement within a city.

LAC has a rich set of experiences in urban mobility policies. Some have been very innovative and have inspired similar reforms in other parts of the world. However, some reforms have been more successful than others. There are two main lessons from the current review that need special attention for policymakers.

First, designers must always place themselves in the shoes of individual travelers. In the case of public transport passengers, how will access times and waiting times change? Will they have to make additional costly transfers after the reform? Are frequencies going to be similar or higher? Will in-vehicle travel times decrease significantly and compensate for increases in access and waiting times? What about comfort? Will they have to stand or are there sufficient seats in the bus or carriage? It is crucial to answer these questions prior to implementing a given reform. Users will not be better off just because new buses are introduced or operators are now formal companies with well dressed drivers. They care much more about time and affordability.[39]

In the case of private transport, will users change their behavior in ways that can compromise the effectiveness of the policy? Do they have incentives to circumvent regulations by purchasing additional vehicles? Will they really switch to public transport or will they opt for informal paratransit instead? Once again, it is important that these questions are addresses during the policy design stage. Much can be learned from regional experience to avoid repeating common mistakes.

The second major issue, is that the type and scope of a reform should depend on available resources. This is obvious in the case of metro or commuter rail investments, since they will almost always be funded through public expenditure or grants. But it is less obvious in the case of bus reforms. If fare increases are not feasible and subsidies are not available –either to build the required infrastructure or to partly fund the higher operational costs of mod-

[39] A recent study by Alonso et al. (2024) using survey data from the Dominican Republic indicates that users rate punctuality, accessibility and frequency of public transport modes –all determinants of access and waiting times– higher than security/safety, cleanness and comfort. This suggests that it is these features that prompt users to use a given mode despite having an otherwise low overall perceived quality. The possibility of making trips without costly transfers is also a prime motivation for using these low-quality modes.

ern high quality systems– then it may be advisable to lower the scope and ambition of the reform. Experience in LAC indicates that it is a bad choice to fund a costly bus reform through fleet reductions and the introduction of high capacity buses. Subsidies should be an integral part of the financing equation of high-quality modern bus reforms.

The good news is that there is a continuum of policy options to choose from according to available resources and local conditions. Low cost bus lanes, open bus priority infrastructure and the introduction of toll charges and regulations can significantly improve urban mobility. Parking and congestion charges can also provide a funding source for other components of a reform. For sure, these alternatives are not as iconic or politically profitable as a high-profile infrastructure project. But neither are ambitious projects or reforms that fail to meet their mobility and financial objectives.

Finally, it is relevant to conclude this document by stating the obvious. Improving urban mobility does not rely on a single policy or reform. Many different initiatives both in infrastructure as well as pricing regulation are required, in active as well as motorized mobility. It is also a continuous effort through time. As LAC cities grow and evolve, possibly influenced by past reforms, urban mobility will remain a challenge. Policymakers need to adapt, innovate and persist in the efforts to improve urban mobility.

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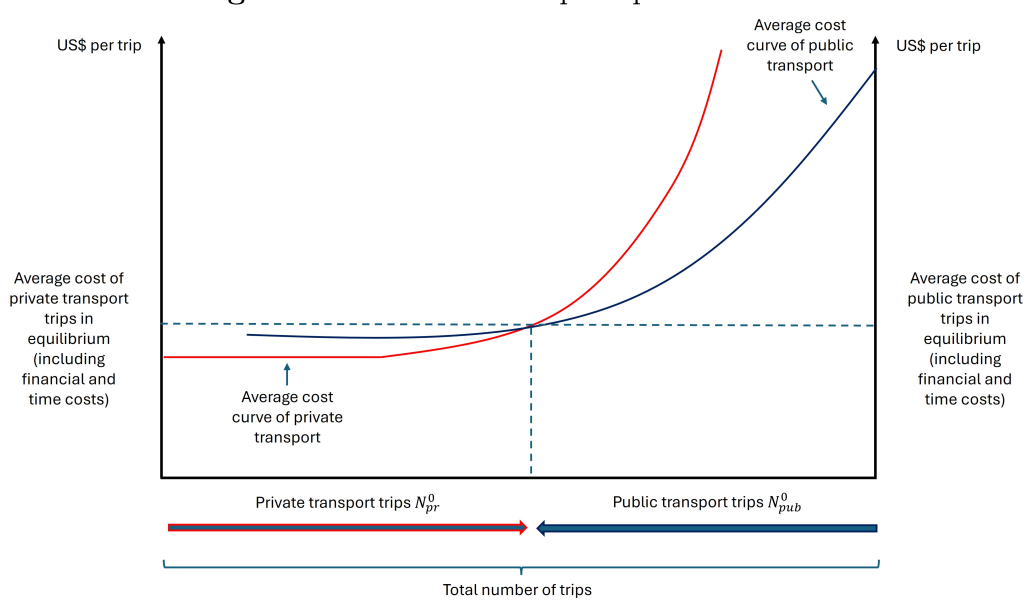
Appendix

The Down-Thompson (Mogridge) paradox

The Down-Thompson (Mogridge) paradox states that under certain conditions the expansion of roads that favor private transport can be counterproductive to reduce congestion and travel times.

This paradox is illustrated using Figure A.1, which presents a simple two mode model (private cars and transit). The horizontal axis represents the total number of trips. From the left to the right we measure the number of car trips and from right to left the number of public transport trips. The left vertical axis measures the average cost of using private transport (including financial and time costs). As the proportion of trips made by private transport increases, congestion intensifies, reducing travel speeds and increasing time costs. This relationship is depicted by the upward-sloping private travel cost curve in the figure.

Figure A.1: Down-Thompson paradox model



The right vertical axis in the figure measures the average cost of using public transport. Unlike private transport, average cost decreases with transit patronage. This occurs because more demand allows for a denser route network and higher operational frequencies, reducing access cost and waiting time costs for passengers.[40] This is called the Mohring effect in the academic literature. Therefore, the average cost of using public transport (measured from the right axis to the left) is decreasing with higher demand for this mode.

To find the equilibrium modal split we assume that users take the trip with the minimum average cost.[41] That is, where the average trip cost is equal between modes. This is represented as N^0_{pr} and N^0_{pub} in the figure.

Now assume that a major road or urban highway project is undertaken that benefits mainly private transport. This is represented in Figure A.2 as a downward shift in the average cost curve for private transport, since travel times will decrease for this mode. The new modal split (N^1_{pr} and N^1_{pub}) implies a higher share of private transport trips and, surprisingly, the equilibrium average trip cost is now higher for all users compared to this cost prior to the investment. This is the paradox. The intuition for this result is that as private transport becomes more attractive, there are less users of public transport. As a consequence, system planners reduce coverage and frequencies, resulting in an increase in access and waiting times. This induces even more passengers to opt for the private transport mode until increased congestion equalizes the average cost of each mode.

It is easy to verify with the figure above that policies that tax the use of cars will shift the private transport cost curve upward, reducing the equilibrium average trip cost. Likewise, policies promoting the use of public transport (transit investments, bus priority infrastructure or subsidies) will shift the public transport cost curve downward, reducing the average travel cost for all.

[40] A denser route network implies that users on average will walk a shorter distance to and from bus stops (or subway/train stations) and higher frequencies imply that, on average, they will have to wait less for a bus/metro/train to pass.

[41] Some heterogeneity in preferences must be assumed in the model to avoid corner solutions where all users take one or the other mode. See Basso and Jara-Díaz (2012) for a model with more sophisticated modelling of modal choice.

Figure A.2: Down-Thompson paradox model with private transport enhancing investment