

Political determinants of sustainable transport in Latin American cities

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Political determinants of sustainable transport in Latin American cities

Carlos Cadena Gaitán

Maastricht Economic and social Research institute on Innovation and Technology (UNU-MERIT)

email: info@merit.unu.edu | website: <http://www.merit.unu.edu>

Maastricht Graduate School of Governance (MGSOG)

email: info-governance@maastrichtuniversity.nl | website: <http://mgsog.merit.unu.edu>

Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands

Tel: (31) (43) 388 4400, Fax: (31) (43) 388 4499

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Political Determinants of Sustainable Transport in Latin American Cities

Carlos Cadena Gaitán
United Nations University – MERIT/Maastricht Graduate School of Governance
cadena@merit.unu.edu

Abstract:

This paper examines patterns within the broad trends towards sustainability in transport systems of Latin American cities¹. We provide an empirical characterization of the sustainability levels for several urban transport systems in this region, and use it as the base for comparing and contrasting the levels of engagement of each city with the principles of sustainability in transport. We perform this characterization by composing a ranking that rates transport sustainability as an aggregation of its three core dimensions: social, economic, and environmental. We present this ranking as the ‘Green Transport Index for Latin American Cities’.

Keywords: green transport, sustainable transport, sustainability index, transport policy,
Latin America.

JEL Classification: O18, R48

Words: 5460 + tables and cover page: 5800.

¹ When we explicitly refer to cities, we are actually referring to the metropolitan areas of these cities (unless otherwise noted explicitly).

Urbanization and its discontents

The cities of our world are growing rapidly. In developing countries, the rate of urban demographic growth follows a peculiar trend; not only has it continued to accelerate, but also takes place in an often chaotic and disorderly way. In fact, a vast proportion of this urban growth is concentrated in informal settlements characterized by precarious living conditions and difficult accessibility to employment opportunities; hence, posing immense challenges to governments. Some think of this urbanization phenomenon as the fastest in our history, one that calls for urgent actions to be taken in guaranteeing more sustainable rates of urbanization. For example, in the last sixty years, between 1951 and 2011, the global urban population enlarged almost five times (UN-HABITAT, 2011), sparking worries about the capacity of our cities to plan accordingly, so as to assimilate these new urban dwellers and allow for their increased well-being.

Urbanization is not necessarily a negative phenomenon. In fact, agglomerating populations in well-designed cities creates obvious positive externalities. People may access resources easier, produce cheaper goods, and trade more effectively. Similarly, we can actively participate in societal life, exercise our political rights and duties, and share similar urban spaces with others. Urbanization has evidently been the one condition, allowing our cities to become the fundamental places where social and political life takes place, knowledge is created and shared, and various forms of creativity and art are developed (UN-HABITAT, 2010).

With 50% of the world's population already living in urban areas, these not only generate the majority of global greenhouse gases, but also use over two-thirds of the world's energy. By 2030, cities are expected to account for at least 60% of the world's population and use more than 12,400 Mtoe of energy (KPMG, 2010). By this year, all developing regions, including Asia and Africa, will have more people living in urban than rural areas (UN-HABITAT, 2011), thus generating the need for smarter cities. The situation in Latin America might even be more extreme; according to the United Nations Population Division, this is the most urbanized region in the developing world, with 81% of its population living in cities. This percentage is expected to rise further; by 2030, the figure could reach 86%, on a par with Western Europe (Economist Intelligence Unit, 2010).

Transport as a vital component of urban sustainability

One specific area to tackle when studying urban sustainability concerns transport systems. These, not only are inherently tied to the urban levels of environmental pollution and congestion, but also deal with the vital structure that allows citizens to mobilize, and thus, fulfill their social and economic needs.

Unfortunately, the still reigning car-dependency in the cities of our world generates serious social, environmental and economic damages. A number of studies show that transportation currently consumes more than half of global liquid fossil fuels; consumes between 20% and 50% of total urban energy consumption; emits nearly a quarter of the world's energy related CO₂; and generates more than 80 per cent of the air pollution in cities in developing countries (ITDP & Gehl Architects, 2010; B. Lefèvre, 2010; UNEP, 2011). This ancient car-dependency reflects a fossil-fuel-thirsty motorization model that has become entrenched in countless cities. With greater awareness of its dangers, and sufficient empirical evidence, there is a growing consensus on the need for a *paradigm shift* towards greater sustainability in transport planning (Litman 1999; Litman 2009; Banister, 2008).

In this article we explore the current trends towards more sustainable patterns of transport in Latin American cities. We concentrate on the concept of 'Green

Transport'², coined by the United Nations Environment Programme, referring explicitly to one that supports (1) environmental sustainability through the protection of the global climate, ecosystems, public health and natural resources; (2) economic sustainability through an affordable, fair and efficient transport that promotes a sustainable competitive economy as well as balanced regional development and the creation of decent jobs, and; (3) social sustainability by allowing the basic access and development needs of individuals, companies and society to be met safely and in a manner consistent with human and ecosystem health, while promoting poverty reduction and equity within and between successive generations (UNEP, 2011).

Sustainable transport or – green transport – is proposed as an avenue to break the invisible borders of marginalization brought about by chaotic urbanization. Transport not only empowers citizens to have access to jobs, education, and entertainment, but it is now conspicuous that adequate urban mobility systems are a *sine qua non* condition for cities to grow more sustainable. Proponents of urban sustainable transport have extensively addressed the difficulties in achieving sustainability (Banister, 1998; Gakenheimer, 2004). We now know that moving towards sustainability in transport not only implies a paradigmatic change in the way societies understand their mobility, but also requires important technical and political steps. Various paradigms for managing societal mobility needs are tied to specific transport planning approaches. Since the second half of the 20th century, the dominant paradigm in urban transport planning had been one of maximizing personal mobility (Cervero, 2001). This approach focused on auto-mobility and became known as ‘predict and provide’. It was centered on providing the needed infrastructure according to the predictions spurned by mobility growth models. Challenges to this dominant discourse arised in the 1990’s, pointing at the evidence that “road construction generates induced demand for road travel” (Vigar, 2001, p. 427) and a growing awareness of the negative effects of increased car travel on social and environmental conditions. This emerging paradigm, known as the ‘predict and prevent’ approach, called for avoiding predicted mobility by discouraging the use of the car, while promoting alternative means of transport (Goodwin, 1991; Owens, 1995). This last approach is no longer supported by many authors, since “it ignores the degree to which the well-being of households and the viability of companies have become dependent on rapid and cheap mobility” (Bertolini, 2009). The challenge presented by this dilemma then, concerns the reconciliation between vital mobility and its inherent negative social and environmental effects, considering the high reversal costs caused by previous decisions.

Methods

Our *Green Transport Index (GTI)* scores sixteen cities³ from nine different Latin American countries, across three broad baskets – environmental sustainability, social sustainability, and economic sustainability – using 16 indicators. All of these, aim at quantitatively measuring how each city is performing (both in terms of quantity and quality). Thus, we do not include qualitative assessments of cities’ aspirations or proposals, as we assume for this paper, that Latin American policy-making is often marked by a disconnection between political rhetoric and policy action; leading to notable plans and proposals that frequently do not materialize.

² Throughout the paper, we use the concepts of ‘sustainable transport’ and ‘green transport’ interchangeably, reflecting the precise definition hereby presented.

³ For general descriptions of the chosen cities, please consult the annex.

Apart from using this ranking as a measurement tool, we also aim at providing a powerful decision support tool⁴ for planners, decision-makers and activists in Latin America. The index showcases variations on sustainability outcomes for the studied cities – hence serving as a measurement tool – but simultaneously stimulates policy action for the relevant actors, due primarily to its nested structure. We compose the final ranking by linearly aggregating all normalized scores in the underlying indicators. However, we first aggregate the sub-indicators for each basket, creating three separate scores for each category. By maintaining these sub-indices separate, we understand that a deficit in one indicator may be compensated by a surplus in another (within the same basket); nonetheless, we expect this can concomitantly help to discern the political trade-offs faced by policymakers when deciding on projects and policies.

Most of the indicators and structural variables considered reflect data from 2009. However, some data actually correspond to 2007, as it takes at least two years for it to be collected, analyzed and published. When some specific figures were impossible to collect, we produced estimates from national measures of central tendency. The environmental basket reflected some of these gaps, as local governments in the region often fail in recording a number of these measures. Clearly, for some of these cities, quantifications of CO₂ emissions could actually be solely estimates of fossil fuel consumption (Parlow, 2011, p. 40), for example.

All final individual indicators receive equal weighting in the index, thus implying that all are deemed to be equally important in promoting transport sustainability, under the context of our definition, the applicable literature, and the strategic goal of serving as a decision support tool for relevant local actors. However, our final choice of indicators reflects a heavy emphasis on the social aspects of green transport, as described in our aforementioned definition. Hence, even though each basket is also rebased onto a scale of 0 to 10, the final index does not aggregate the three previously aggregated scores for the baskets, but uses instead a fresh 16-indicator linear aggregation.

In order to make data points comparable across cities and to further build the aggregate scores, all qualitative indicators were normalized using a *min-max* technique. We used a [0 – 10] range by subtracting the minimum value from the value to be normalized, and then dividing by the range of the indicator values.

The indicators chosen to compose the *GTI* (see Table 1) are not intended to become an exhaustive nor ideal list for analyzing sustainable transport wherever. In fact, we are aware that “highly complex, ill-defined or contested phenomena (like ‘sustainable transport’) are particularly at risk of generating indicators that misguide or legitimize rather than inform actions” (Joumard & Gudmundsson, 2010, p. 35). As such, we have focused on selecting valid indicators for measuring the current transport trends, strongly considering the particularities of the Latin American political context. Moreover, from lists of indicators suggested by Litman (2009) and Marsden, et al., (2005), we have concentrated on those indicators rated as having the highest priority of usage according to the sustainability categories they represent.

⁴ For an insight into the use-categories for sustainable transport composite indicators, please refer to the work of Joumard & Gudmundsson 2010.

Finally, we must re-state that the *GTI* shows cities' performance relative to each other, not in absolute terms; this produces the first vital conclusion for the region: all cities still have a long way to go before claiming advanced levels of sustainability in their urban transport systems.

Table 1. List of Indicators Used in *GTI*

Category	Indicator	Description	Influence on GTI
Environmental	Emissions	CO, Nox, SO2, PM, CO2 Emissions in tons. Individual and Collective transport. Per capita, per year.	-
Environmental	Energy Consumption	Equivalent Tons of Oil for Individual and Collective transport. Per capita, per day.	-
Social	Daily Trips	Walking, Biking, Individual, Collective transport. Per capita.	-
Social	Personal Mobility Index	Number of daily trips per inhabitant including all modes.	+
Social	Travel Time	Average Minutes per Trip. Individual transport includes only trips made by car, taxi, motorcycle. Collective transport includes only trips made by bus. Walking includes estimations of all trips.	-
Social	Mortality Index	Yearly deaths in traffic accidents. Per capita.	-
Social	Mass Transport Network	Total length of all train, tram, subway, bus and other mass transport routes within the city's boundaries; measured in km/km ² .	+
Social	Superior Public Transport Network	Total length of all superior modes of transport (lightrail, trolleybus, tram, subway, and BRT) routes within the city's boundaries; measured in km/km ² .	+
Social	Priority for Public Transport	Kms w/ Priority Demarcation for Collective Transport (simple demarcation to separate lane).	+
Social	Priority for Pedestrians	Kms pedestrian only streets.	+
Social	Priority for Cyclists	Kms of priority lanes for bicycles.	+
Economic	Stock of Cars and Motorcycles	Total stock of cars and motorcycles, with half-weighting allocated to motorcycles; measured in vehicles/person.	-
Economic	Cost of Fuel	Gas liters that can be bought with one minimum wage.	-
Economic	Relative Cost Public Transport	Relative weight of 50 bus tickets on minimum wage (2007 USD).	-
Economic	Relative Cost of a 9km Trip	Car and motorcycle trip are estimated by calculating: [(gas use coefficient {lit/km} * 9km) * (cost of gas coefficient)]; Collective transport is average price of ticket. 2007 USD.	+
Economic	Investment in Superior Public Transport	Investment in superior public transport modes as proportion of investment in roads (2007 USD Millions).	+

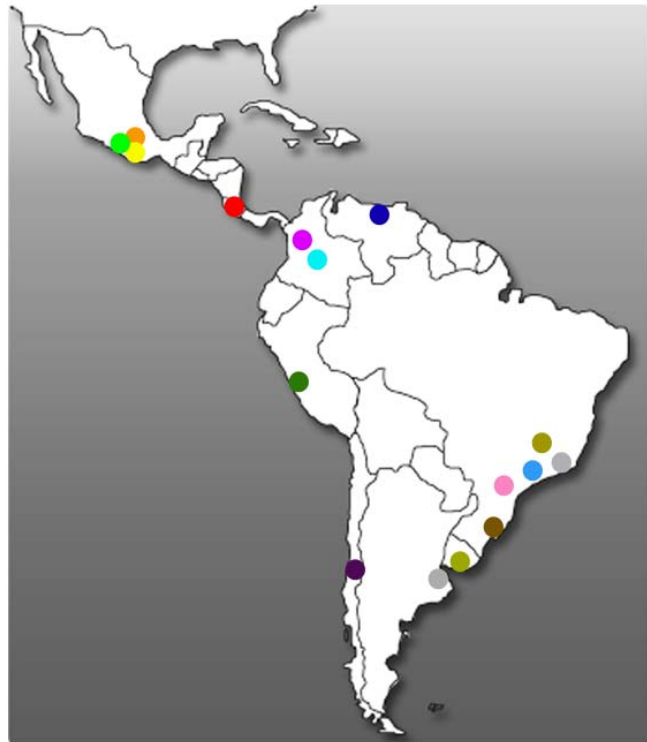
Index Results

This paper explores sixteen major cities spanning the full extent of the Latin American region (see Figure 1). We have chosen these cities hoping to represent a vigorous mix of Latin American urban regions, but essentially constrained by the availability of comparable data.

Figure 1 – Studied Cities

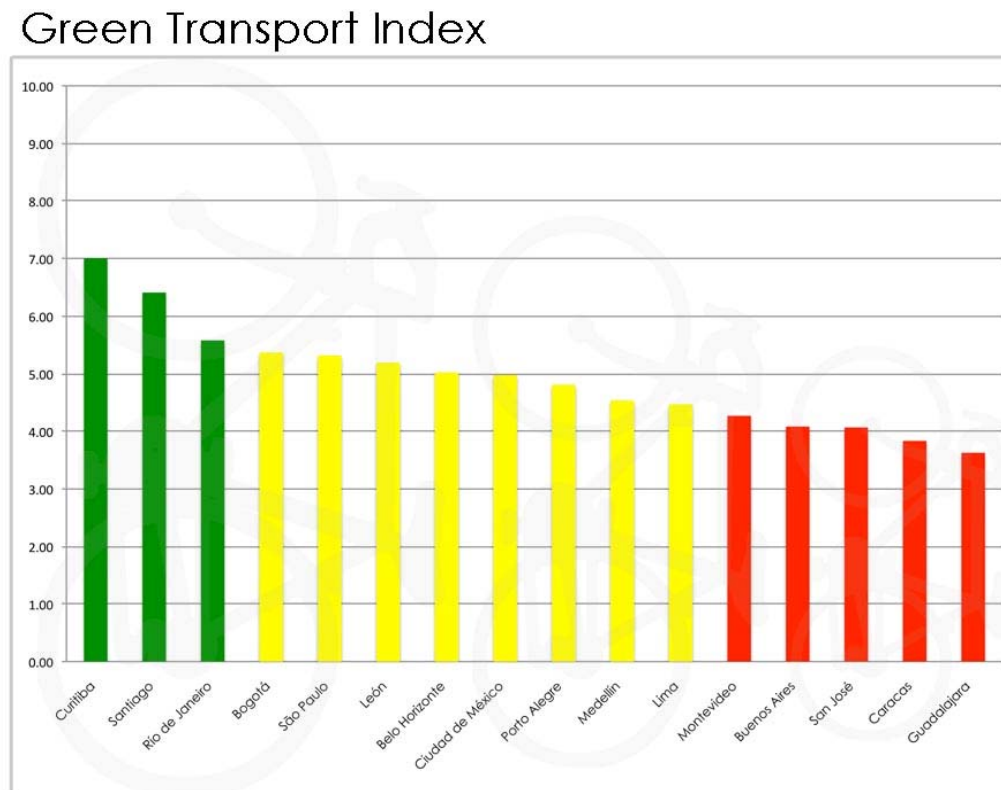
16 Studied Cities

- Guadalajara
- León
- Ciudad de México
- San José
- Caracas
- Medellín
- Bogotá
- Lima
- Belo Horizonte
- Río de Janeiro
- São Paulo
- Curitiba
- Porto Alegre
- Santiago
- Montevideo
- Buenos Aires



Our theoretical and methodological frameworks noticeably value those transport policies and projects providing incentives against car-dependent models, and in favor of collective transport and non-motorized transport. As such, our findings suggest the existence of three broad groups of cities, which we have organized according to their performance in the final ranking: the *top*, *average*, and *poor* performers. Figure 2 exhibits the overall results of the final ranking, using green bars to represent the top performers, yellow bars for the average performers, and red bars for the poor performers. We observe a clear leadership from Curitiba, followed by Santiago and Rio de Janeiro.

Figure 2 – Green Transport Index Results



Caden Gaitán, 2012

Own calculations

Our findings leave Brazilian cities in good standing, with all of the ones hereby studied ranking as top or average performers. Moreover, we confirm previous academic findings that have placed Curitiba as the regional leader in transport sustainability. Led by former mayor Jaime Lerner, Curitiba is credited with inventing the “bus rapid transit” (BRT). Its promoters tout it as the perfect substitute for regular metro systems in cities with low transport budgets. Although these systems exhibit very high usage levels (i.e. 1,780 - 43,000 passengers/hour/direction), clearly comparable to some metro systems, their construction usually costs a fraction of that for an average metro (EMBARQ, 2010). Curitiba also boasts a vast network of pedestrian only streets and cycle paths, complementing master urban planning policies that successfully reduce long commuting times, and provide comfortable and economic alternatives to the private car.

Santiago’s position reflects recent specific actions against car-dependency. It continues to be the only city with congestion charging policies in place, having begun with the *Costanera Norte* expressway. The city’s ranking reflects the grand effort to reform its transport system through *Transantiago*; a massive project that brought all bus operators under one organization, fully integrated with both the metro system and the novel BRT system. It is crucial to note that Chile’s capital exhibits one of the smallest stocks of cars and motorcycles in the region, at just 0.14 vehicles per person (Economist Intelligence Unit, 2010); significantly lower than the average for all analyzed cities of 0.28. Similarly, Rio de Janeiro’s strong standing in our ranking is partly due to its vast public transport system; the most expansive one from the studied cities (measured in proportion to city size). Apart from quality metro, bus, light rail,

and water buses, the city offers a growing network of cycle paths; thus, providing valuable alternatives to individual private motorized transport. Rio has a low ratio of cars and motorcycles per inhabitant, at only 0.26 (Economist Intelligence Unit, 2010). This is both less than the average for all studied cities, and also the lowest ratio among the Brazilian cities analyzed.

Our findings leave Guadalajara and Caracas at the bottom of the ranking. Although Guadalajara boasts an interesting multi-modal mass transport network (metro, light rail and buses), it suffers from price inconsistencies and an uncomfortable lack of integration that results in increased costs to collective transport users. At the time of our measurements, Guadalajara had built zero kilometers of bike lanes, and pedestrian infrastructure continues to be deficient. Moreover, Guadalajara's performance in the ranking is affected by policies that have provided clear incentives to increase car dependence; amongst these, significant tax cuts for car owners, and large scale – yet citizen contested – proposals for new urban highways. The situation in Caracas, however, seemingly reflects the consequences of highly subsidized gas. Due to an ancient official national government policy, buying gas in Venezuela continues to be cheaper than buying bottled water; as such, traveling by car is drastically cheaper than in any of the other studied cities.

Although Curitiba confirms its overall regional leadership, no city was found to lead (or occupy the last position in) all three baskets of transport sustainability; environmental, social and economic. Evidently, all cities have much to improve in specific components of their transport sustainability mix.

Environmental basket of transport sustainability

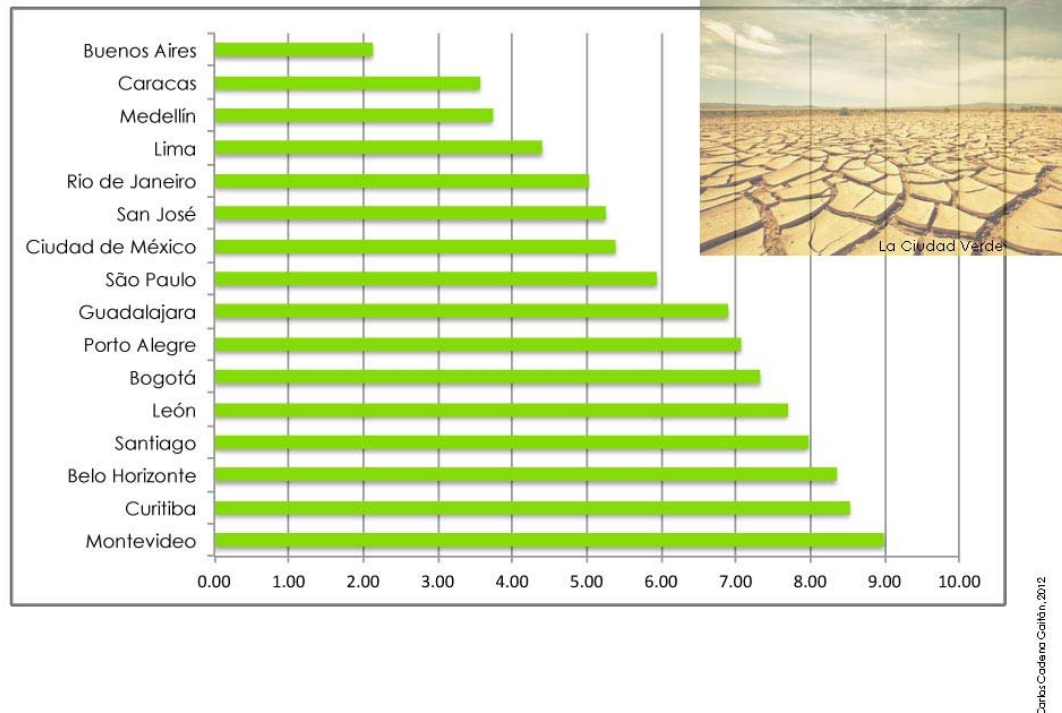
Within this basket, we aim to capture each city's contribution to global climate change; essentially, via measuring air pollution (both in terms of acidifying gases, and volatile organic compounds from transport), and the consumption of natural resources to power transport.

The top performers in this basket include Montevideo, the capital city of Uruguay, and Curitiba (see Figure 3). Montevideo profits from sitting on an estuary with a free connection to the open sea; this undoubtedly helps to disperse air pollution. Furthermore, the city government has established strict air quality codes and monitoring systems, highlighting their intention to reduce their overall contribution to climate change. However, this positive performance in the environmental basket for transport sustainability is not backed by equally superior performance in the remaining baskets.

In terms of air pollution, we analyze levels of carbon monoxide (CO), nitrogen oxide (NO_x), sulfur dioxide (SO₂), particulate matter (PM), and carbon dioxide (CO₂) for both individual and collective transport. Overall, Montevideo, Curitiba and Belo Horizonte exhibit the lowest emission of green house gases (GHG) as compared to the remaining studied cities. In regards to energy consumption, Montevideo once again scores highest, with the lowest scoring city located right across the River Plate; Buenos Aires. Although we have insufficient evidence to explain this phenomenon, such a sharp difference might be due to urban density. While Buenos Aires boasts an immense urbanized area of 3,883 km², and a low population density of 3,389 inhabitants/km, Montevideo profits from a population density that is almost twice as large as that of its neighbor (6,509inh/km), conveniently packed in a much smaller area (196 km²).

Figure 3 – Environmental Basket Results

Environmental Basket



Own calculations; image credit: www.LaCiudadVerde.org

Social basket of transport sustainability

The composition of this basket favors highly mobile societies with low dependence on the automobile, as well as broad urban systems that offer affordable and equitable opportunities to mobilize about the city, via collective and/or non-motorized transport. Under this framework, Curitiba stands out as the overall undisputed leader, partly due to the large number of kilometers with priority for collective transport, bicycle lanes (second only to Bogotá's 300 km), and leadership in kilometers for pedestrian only streets. Moreover, Curitiba exhibits the lowest proportion of deaths in traffic accidents, at only 2/100.000 inhabitants in 2007. In stark contrast, Guadalajara suffers greatly from what many consider to be transport's central public health concern; it showcases the highest proportion of deaths in traffic accidents, with 16/100.000 inhabitants for the same year. In terms of accessibility to jobs, education and entertainment, Santiago leads with an average of 3 daily trips per inhabitant; highly skewed towards collective and non-motorized transport modes. San José scores lowest in personal mobility, with only 1.2 daily trips per inhabitant in average, and Buenos Aires' daily trips by mode performance, leaves it as both the most-car dependant, and least bike-dependant city from our sample. Regarding travel times, Montevideo and the Brazilian cities of Curitiba and Porto Alegre present similarly low average travel times – under 30 in average per trip –, while Bogotá's performance reveals high levels of traffic and congestion, ranking lowest in this category, with 55 minutes in average per trip.

Figure 4 – Social Basket Results

Social Basket



Own calculations; image credit: www.LaCiudadVerde.org

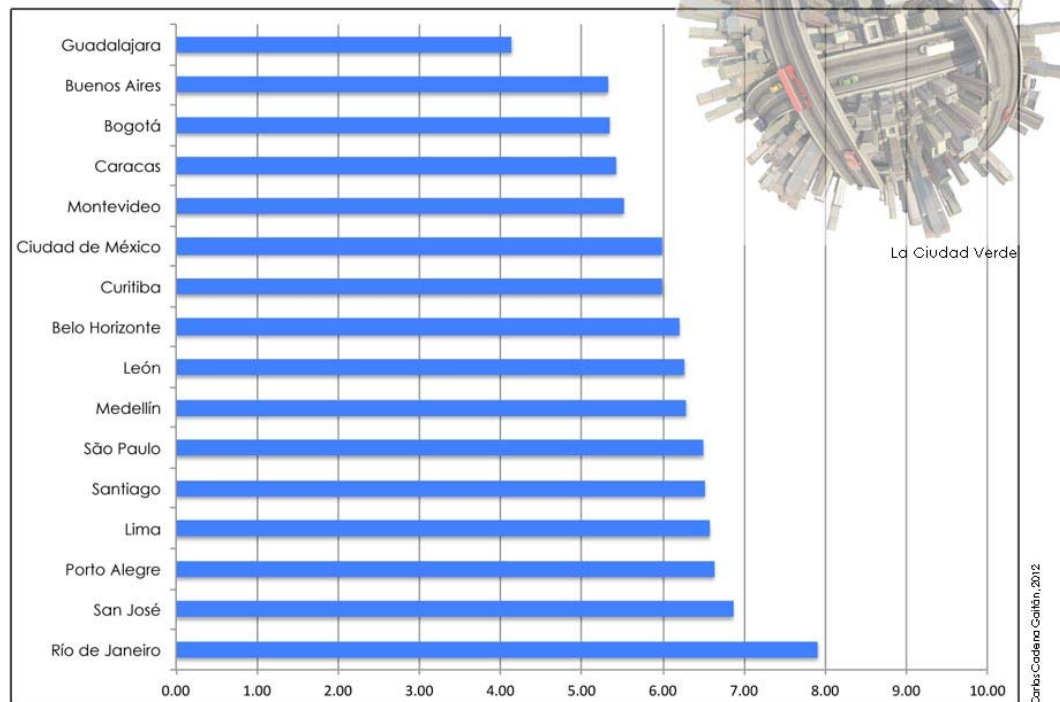
Finally, as it refers to the quality of the collective transport networks, Rio de Janeiro ranks at the top, exposing the most extensive network, and qualifying – a significant proportion of it – as superior modes of collective transport (i.e. metro, LRT, BRT). In this same context, Montevideo and Lima are severely castigated for depending highly on fossil fuel powered buses, due specially, to the lack of an electrically powered mass transport system. Lima has more recently succeeded in revamping its decades-old stalled metro project, yet this event is not accounted for in our data.

Economic basket of transport sustainability

Within this last basket we intend to measure the costs of travel for users, the levels of car and motorcycle ownership, the costs of energy use, and the public prioritization of investment in superior modes of collective transport. Rio de Janeiro tops this basket due to the positive combination of affordable travel in collective transport modes, the above-average costs for car travel, and the significant public investments in superior modes of collective transport. For 2007, Rio de Janeiro invested US\$6,118 million in roads, while investing almost double of this (US\$12,800 million) in superior modes of collective transport (CAF, 2009). In terms of private car and motorcycle numbers, we find an average of 0.28 vehicles per person (with half-weighting allocated to motorcycles) for all the studied cities. Rio stands below the average at 0.26 vehicles per person, while Buenos Aires ranks lowest with 0.66 vehicles per person. Curiously, this is one of the measures where Curitiba fails to hold an above average rating, with 0.50 vehicles per person.

Figure 5 – Economic Basket Results

Economic Basket



Own calculations; image credit: www.LaCiudadVerde.org

We must highlight the fact that our data reflects the actual transport infrastructure in place by the start of 2008, and thus the associated sustainability levels at that point in time. We are aware that several important developments might have taken place since this date, yet difficulties in collecting appropriate and comparable data force us to exclude the associated advances in sustainability.

Patterns in Transport Sustainability

There is no simple answer to why some Latin American cities are doing better on transport sustainability than others. We began our exploration by focusing on the potential explanatory power of commonly referred to variables. However, we find that city performance in our *GTI* does not easily correlate to GDP per capita, size of the city, size of the population, nor population density; although this last variable does raise some interesting thoughts. At the end, political variables seem to have higher explanatory power for cities in this region.

Urban sustainability is a complex phenomenon permanently influenced by a wide diversity of factors. For example, it is often said that “the bigger the city, the worse its climate profile” (KPMG, 2010); certainly, the size of a city and the size of its population affect any urban balance, but this relationship is not at all straightforward. Having larger populations simply means having more people that need to gain access to resources, and more people that generate waste; similarly, covering larger areas could mean that resources previously located within city boundaries, now can only be found outside of them, with the negative consequences in transport and energy costs that this may bring. Nevertheless, the magnitude of these effects could actually

depend on the urban planning processes that have taken place historically in any specific area. Thus, generating in our results a mix of higher and lower sustainability levels, with no direct correlation to the size of the city, nor the population.

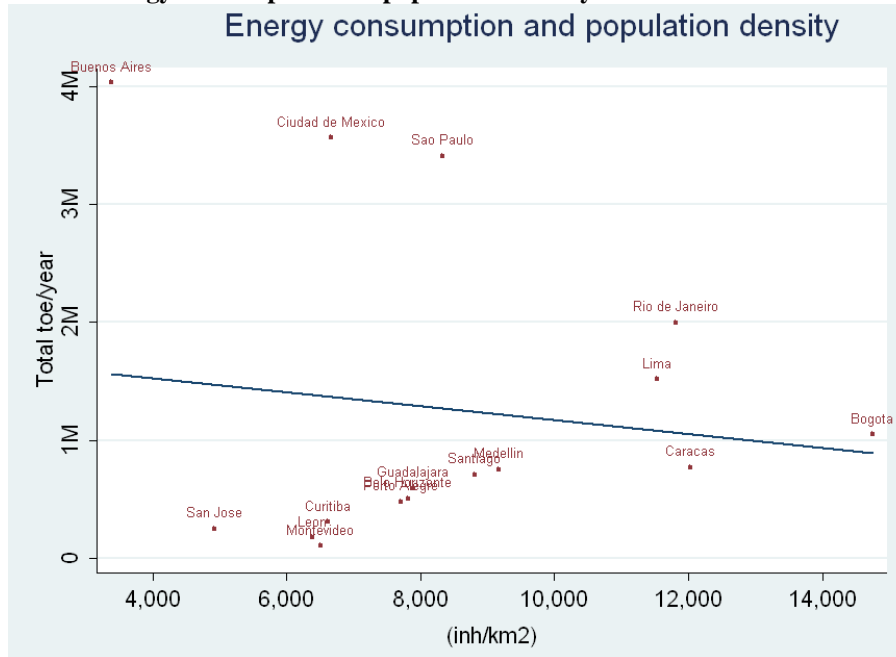
Similarly, the average wealth of the city is often proposed as a fundamental variable affecting urban sustainability. Some studies show that urban carbon footprints increase as the incomes of its inhabitants increase. At the national level, for instance, a doubling of consumption levels brings, in average, an increase of 57% in its carbon footprint (WWF, 2010). In the context of developing countries, income levels are often tightly related to motorization. Some authors argue that there is a specific income threshold at which people move into cars; Ohmae set this threshold at USD 5000 in his studies of Asian cities during the 1990's, for example (Ohmae, 1996). Many others, have also provided empirical evidence to conclude that in developing world cities, "rising incomes are the major driving force for car ownership" (Mohamad & Kiggundu, 2007, p. 1). Furthermore, the evident economic benefits brought about by the car industry (i.e. taxes, provision of inputs, direct and indirect jobs, etc.), could result in strong links with the cities that house them. Yet, in the case of the cities we studied, none of these three fundamental variables seem to correlate with the ultimate ranking in transport sustainability.

Population density is also often quoted as influencing urban sustainability (Bertaud, 2004; Breheny, 1992; Benoit Lefèvre, 2009). Precisely because "it is the [urban] density that makes particular energy and climate measures effective (or not)" (KPMG, 2010, p. 12). Some of the pioneers in urban transport sustainability research, Newman and Kenworthy, provide evidence for a correlation between urban density and transport-related energy consumption. Their famous 1989 hyperbola⁵ planted the idea that low-density urban areas are repeatedly correlated with high car-dependence, and thus, high (transport-related) energy consumption per capita. On the other hand, their studies propose that high-density urban areas exhibit greater use of collective transport modes, hence totaling much lower average rates of energy consumption per capita.

Our results show a weak correlation between overall transport-related energy consumption levels and overall urban density for the Latin American cities analyzed. Although some highly energy intensive cities, such as Buenos Aires, and Ciudad de México have lower than average population densities, there seems to be no clear trend relating these two variables for our cases (see Figure 6).

⁵ See (Newman, Newman, & Kenworthy, 1989).

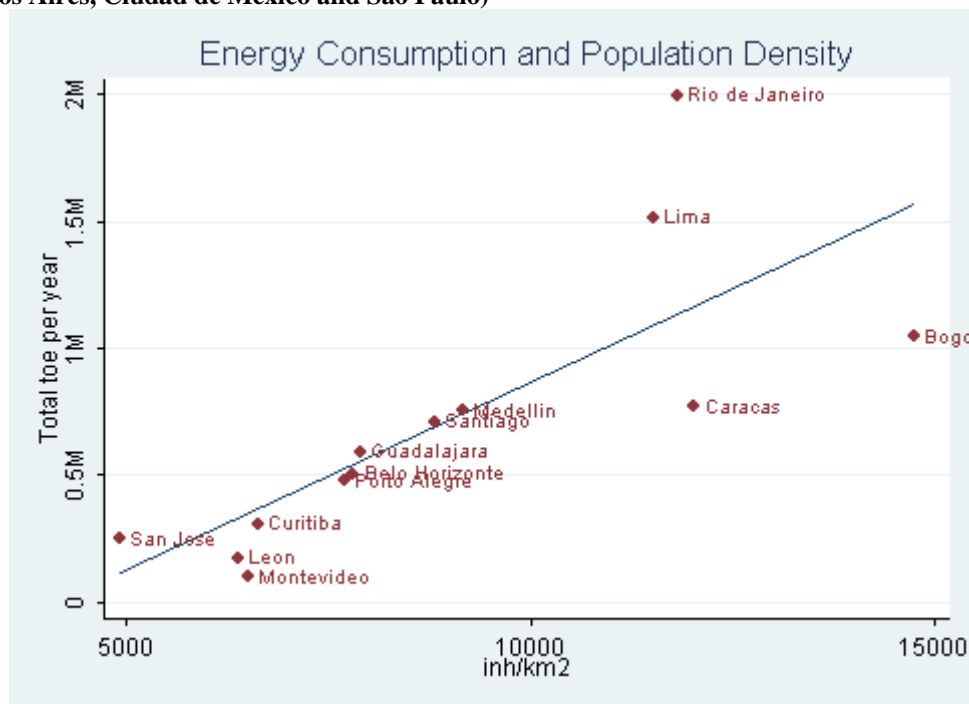
Figure 6 – Total energy consumption and population density



Source: EIU2009, América Economía 2010; own calculations.

In fact, if we are to manually exclude these three mega-cities from the analysis, the slight downward trend, now becomes a clear upward trend, reflecting an unexpected situation in which cities with higher population densities seem to correlate with higher overall energy consumption from transport (see figure 7).

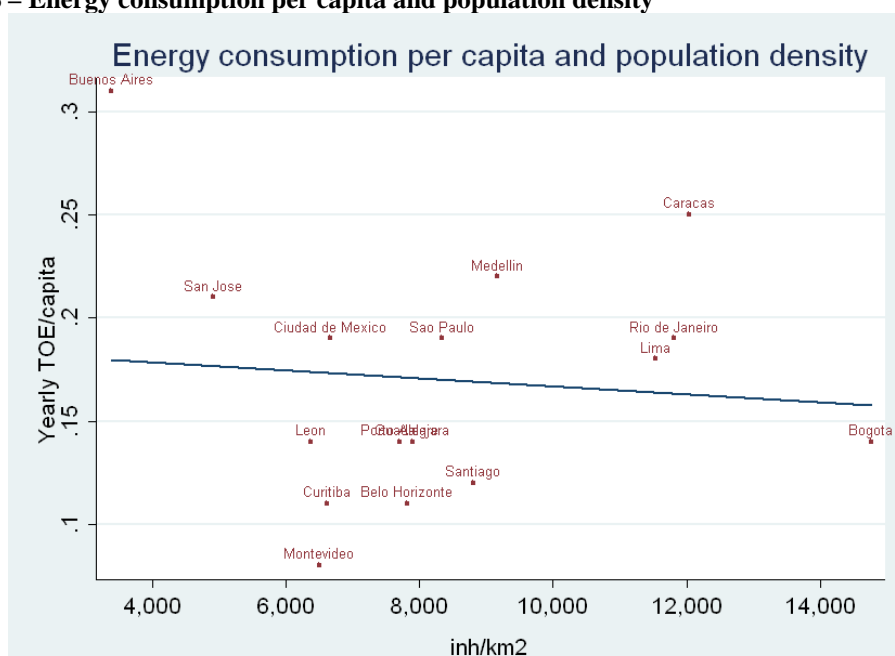
Figure 7 – Total energy consumption and population density (without the 3 Mega-Cities of Buenos Aires, Ciudad de México and Sao Paulo)



Source: EIU2009, América Economía 2010; own calculations.

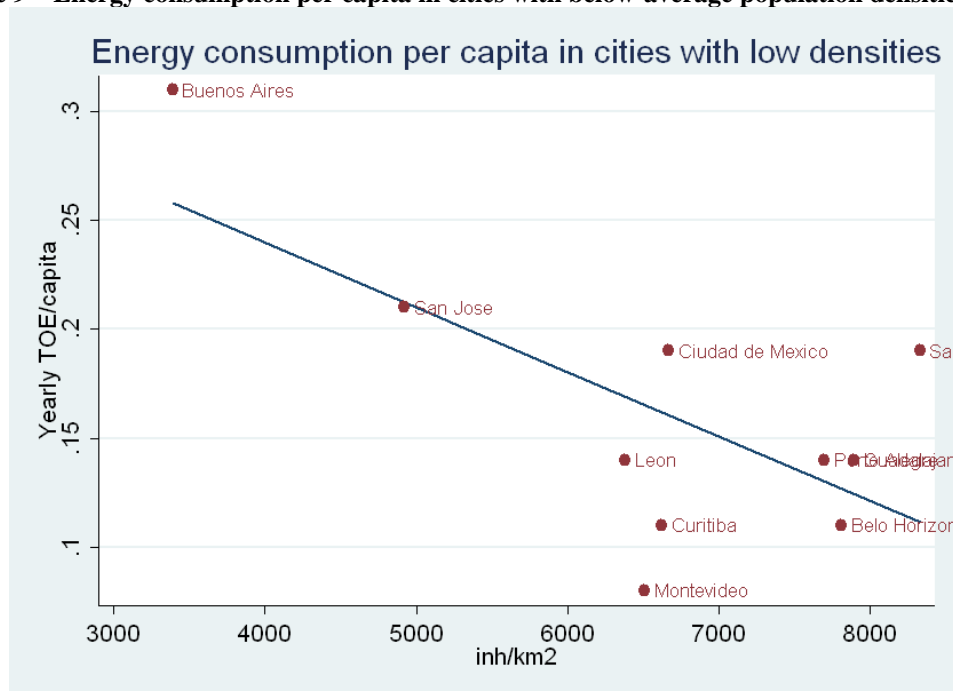
On the other hand, when exploring transport-related energy consumption per capita and population density, we find a relationship that is better fitted to our theoretical expectations. Although we found no crisp correlation between higher densities and lower rates of energy consumption per capita, most of the cities' performances correspond to the expectations (see Figure 8). This relationship becomes even more interesting when we consider only those cities with below average population densities (see Figure 9); here, as population density increases, transport-related energy consumption per capita decreases. Thus, agreeing with previous studies suggesting that higher densities allow for shorter travel distances, and as a consequence, smaller transport-related energy consumption levels. When performing this same exercise for cities with above-average population densities, we find no clear correlations (see Figure 10). Nonetheless, these contradictions pose attractive questions as to the additional political determinants that explain the diverse transport conditions in these cities.

Figure 8 – Energy consumption per capita and population density



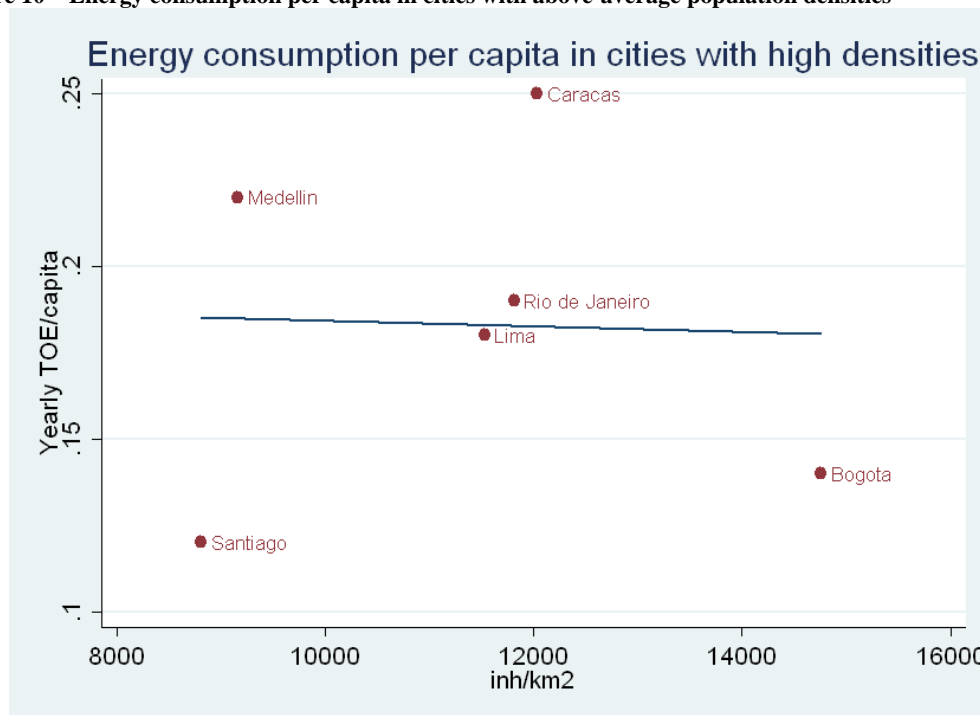
Source: EIU2009, América Economía 2010; own calculations.

Figure 9 – Energy consumption per capita in cities with below-average population densities



Source: EIU2009, América Economía 2010; own calculations.

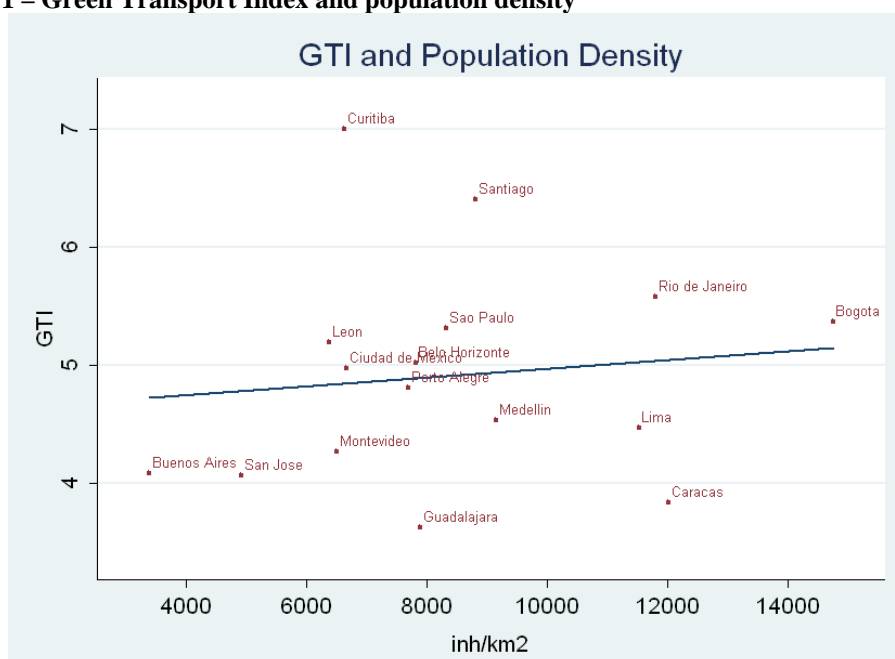
Figure 10 – Energy consumption per capita in cities with above-average population densities



Source: EIU2009, América Economía 2010; own calculations.

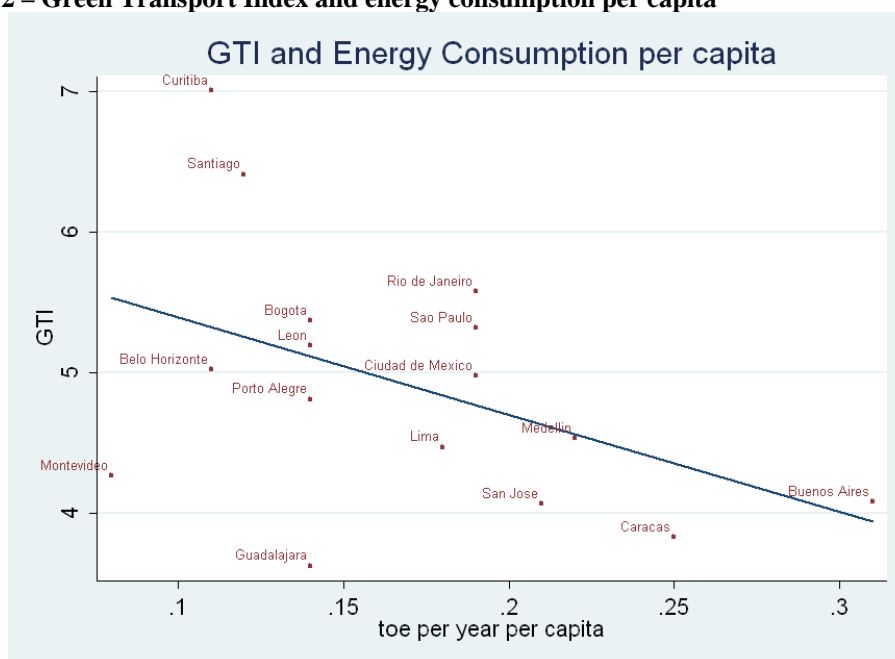
When analyzing the relationship between overall population density and the results of our *GTI*, we find an interesting ascending trend between higher densities and higher results in the index, once again, with some seemingly outlying cases (Curitiba, Santiago, Guadalajara and Caracas), whose specific political conditions, seem to generate merits for further qualitative analysis (see Figure 11).

Figure 11 – Green Transport Index and population density



Source: EIU2009, América Economía 2010; own calculations.

Figure 12 – Green Transport Index and energy consumption per capita



Source: EIU2009, América Economía 2010; own calculations.

Evidently, since energy consumption is considered as one of the key indicators for our index, it is only natural that lower levels of overall transport-related energy consumption per capita seem to be correlated with overall rankings in the *GTI* (although with a very small R^2 of 0.2). However, once again, some apparent outliers present interesting cases for further study (see Figure 12): Guadalajara boasts a below-average energy consumption per capita level, yet, ranks last in our index, Montevideo tops the rankings in energy consumption (and overall environmental performance) yet ranks low in the ultimate index, while Curitiba and Santiago, although with very low energy use rates, rank at the top.

We recognize two additional dimensions that must be accounted for when trying to understand patterns in transport sustainability for Latin American cities: history and politics. In regards to a city's history, we deal with the very one aspect that –by definition– city officials can do nothing about. The consequences of all decisions and actions previously taken should be seen actively affecting transport sustainability today. Some cities have followed particular urban development strategies for years, with evident consequences in terms of transport modal share and energy consumption today. Such is the case of Curitiba, where a political decision was taken in the 1970's to allow for the growth of the city along the broad BRT lanes with the appropriate participation of technical institutions such as *Urbanização de Curitiba* (URBS) and the *Instituto de Pesquisa e Planejamento Urbano de Curitiba* (IPPUC); or the case of Medellín, where due to mediocre urban planning, the city dwellers massively invaded the surrounding hills of the city, thus creating difficult conditions for collective and non-motorized transport modes. If present transport sustainability outcomes are a consequence of the natural and historical conditions of a city, then we would be facing an evident case of path dependent urban dynamics.

Similarly, public policies framing the sustainability of transport systems depend highly on the “involvement of various stakeholders (departments, other governments, private parties, etc.) with varied interests, powers, competences and responsibilities” (KPMG, 2010, p. 13). More often than not, the secretary or cabinet member responsible for transport has little power over public works, social development programs, and/or environmental protection. This, results in ordinary political compromise dynamics; a completely different power game that undoubtedly permeates ultimate transport sustainability decisions, for any modern city. It is imperative to recognize the broader context in which sustainable transport policies are discussed, decided on, and implemented when comparing transport sustainability levels. As Bertolini asserts, “[there is a] need to shift the focus of the effort from devising policy packages to understanding the factors enabling, or impeding their implementation, and thus towards a more experimental, interactive attitude towards policy making” (Bertolini, 2008, p. 71).

The timing could not prove to be better for Latin American cities in advancing their transport sustainability. Many of the studied conurbations still boast very low private vehicle modal shares, and corresponding large shares for collective (specially bus) and non-motorized transport (specially walking). This, however, might not account necessarily for policies aiming at increasing transport sustainability, but rather for the relative economic underdevelopment of these cities. For many decades, succeeding in acquiring a car was a privilege for the very few; thus, leaving no other option for vast percentages of urban populations but to move about the city using bus services or walking. The relative underdevelopment in the planning of many Latin American cities should also contribute in avoiding the errors of others, while taking advantage of the large percentages of citizens that still have not become fully motorized. Likewise, city authorities stand in an advantageous position to take leadership in these issues. Not only do they have the power to plan the future of their transport systems, but also hold diverse regulatory powers.

Our results suggest the need for a deeper exploration into urban transport sustainability levels in Latin America, and their relationship to the political processes framing long-term urban policies. It is clear that numerous cities in the region are actively finding ways to promote their urban sustainability and mitigate GHG emissions (WWF, 2010), however, there is no clear evidence regarding the political conditions that have allowed some of the cities to advance much more than other

conurbations sharing similar structural characteristics. We acquiesce that “governance issues for urban transportation [...] require more extensive analysis” (EMBARQ, 2010, p. 33).

Conclusion

We have presented an empirical characterization of the general trends in transport sustainability for sixteen Latin American cities. In the context of accelerated urbanization throughout the globe, the situation in this region is special; it is expected that 86% of its population will live in cities by 2030 (EIU2010). With financially weak governments and enduring social inequalities, these growing urbanization trends pose worrying prospects to urban sustainability.

One of the central issues to consider when studying urban sustainability, concerns transport systems; both in terms of their positive and negative externalities. This applies especially to those regions where ancient car-dependent transport planning modes, continue to be the ruling paradigm. With greater awareness of its dangers, and sufficient empirical evidence, “there is [now] a growing consensus on the need for more sustainable patterns of transport” (UNEP 2011, p.380).

We have created an index that rates the performance of our studied cities in terms of transport sustainability. This Green Transport Index (*GTI*) presents separate outcomes for the social, economic, and environmental components of transport sustainability, framed under a ‘sustainable-transport-inspired’ structure composed heavily by collective transport modes and non-motorized transport modes. We expect to establish this initiative as a recurring exercise, ultimately serving as a benchmark, and concomitantly providing incentives for political actors in the region to pursue more sustainable transport policies.

There is great potential in converting this green transport ranking into a benchmarking exercise for the region’s cities. This would transcend from a performance measurement for the urban transport systems, to an avenue for influencing the effectiveness of public policies. By identifying front-runners and leading practices, “cities can benefit from the knowledge and experience of colleagues in other cities to assist sustainability policy development” (KPMG 2010, p.10). An obvious requirement for a potential benchmarking exercise would be to measure city performance over time; thus allowing for improvements to be tracked. The key constraint to this possibility in Latin America continues to be the availability of reliable data.

We argue for more sustainable transport systems, as necessary components for modern cities. Previous studies show that cities need new approaches to urban development that privilege the collective well-being. Sustainable transport systems not only need to provide space and resources for new comers, but must also be structured so as to tackle inequalities, while protecting the environment, and promoting economic growth.

Increasing sustainability in transport requires solid urban governance. Moving towards sustainability obviously necessitates appropriate technology and funds; however, it is precisely sound governance, correct planning, and strong implementation capabilities that become crucial in attaining urban sustainability (UN-HABITAT 2002). As such, we believe there is a clear need for high level research focused on effective institutions, successful public policies, and good governance that correlates with high levels of urban sustainability. This exercise offers us one crucial final question: which are the political variables that have determined greater advances towards transport sustainability in Latin American cities?

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ANNEX – List of cities included in the index

City	Main characteristics of the conurbation and its transport system	Rough assessment of sustainability level
Buenos Aires	Population: 13.267.181; Pop. density (people/km ²): 3.388 Twice as big as Sao Paulo and 5 times larger than Bogotá in squared kms. With such an immense urban area, there is a high level of urban sprawl, and coverage difficulties for public transport.	Buenos Aires is recognized for its vast network of highways. With more than 50% of daily trips made by car, this conurbation has the largest dependence on the automobile in this list.
Belo Horizonte	Population: 4.803.198; Pop. density (people/km ²): 7.812 As the third-largest metropolitan area in the country, it is a congested conurbation. A number of federal highways cross the city, complementing the extensive local road network. A vast public bus network runs parallel to the metro system, which is composed of only one line crossing the entire metropolitan area.	Belo Horizonte continues to struggle in integrating the bus and metro systems. Yet, new approaches to the provision of public transport systems are improving the efficiency of the system. As an example, 1.4% of the urban roads now have preferential lanes for public transport.
Curitiba	Population: 2.872.486; Pop. density (people/km ²): 6.624 An important economic center of southern Brazil, Curitiba was the “inventor” of the BRT system, which has become a global alternative to metro systems. In 2010 the city was awarded with the Globe Sustainable City Award.	Curitiba is regarded as the sustainable transport leader in Latin America. With an urban transformation process started in the 1970’s, it has led numerous transport innovations that have been later considered by other conurbations around the world.
Porto Alegre	Population: 3.410.676; Pop. density (people/km ²): 7.702 Porto Alegre boasts a solid privately-run bus. One train line links the city centre to the towns in the north of the metropolitan area: Canoas, Esteio, Sapucaia do Sul, São Leopoldo.	As member of the Sustainable Cities initiative, Porto Alegre has developed an integral urban sustainability plan. It includes the development of new transport technologies and the increased use of biodiesel fuels.
São Paulo	Population: 18.783.649; Pop. density (people/km ²): 8.333 The largest metropolitan area in Brazil is composed by 39 municipalities. Although the Metropolitan Agency for Greater São Paulo was once powerful and effective in transport planning, its capacity has declined over time. Thus, quite dissimilar transport approaches are present in this metropolitan area.	Its transport system is marked by a variety of modes. An immense fleet of private cars rivals an equally immense fleet of buses. Trains, light rail and subway systems, etc. compose the mix of transport modes.
Rio de Janeiro	Population: 10.689.406; Pop. density (people/km ²): 11.813 The Metropolitan Region Area for Rio was created by the military government in 1974 and still is in place; thus, with a central goal of creating efficiency in service provision, these administrative structures often lack coordinating mechanisms with local communities and local institutions.	A good number of sustainable policies have found their way into the policy process; moreover, the city has been chosen as the host for the 2016 summer Olympics, and as such, sustainable transport policies are playing a crucial role in all present metropolitan policy making.
Bogotá	Population: 7.823.957; Pop. density (people/km ²): 14.755 It is considered as a ‘special district’ of Colombia, with 18 sub-municipalities, under the elected mayor of the city, and a ‘metropolitan council’ with absolute authority over many metropolitan-wide urban transport decisions.	Bogotá is one of the benchmark examples of ‘relatively successful’ sustainable transport in the developing world. In less than 10 years, a mass transport system was planned and implemented, a 300 km protected bike network was

		built, and the use of private automobiles was reduced.
San José	Population: 1.286.877; Pop. density (people/km ²): 4.924 Costa Rica has made environmental sustainability a landmark of the nation. However, its capital city continues to suffer from an atomized transport system, promoting urban sprawl and growth of private automobile transport.	As a member of the Sustainable Cities Initiative, San José has committed to building on their existing planning process through the use of a long-term sustainability lens. Major actions in transport are already underway.
México D.F.	Population: 19.239.910; Pop. density (people/km ²): 6.671 The largest metropolis in Latin America suffers from massive congestion, and a complex political system that places obstacles for most decisions concerning its transport system.	Literally all possible modes of transport are actively in use in Mexico D.F. The ‘predict and provide’ approach was eternalized through the construction of the <i>Anillo Periférico</i> , a massive elevated highway crossing the city. Yet, many sustainable policies and projects are currently in place.
León	Population: 1.360.310; Pop. density (people/km ²): 6.382 Although it is only the seventh most populous city in Mexico, it is an industrial and economic center of the region.	With the construction of the first Bus Rapid Transit system in México, <i>Optibus</i> , León has been at the frontline of sustainable transport innovations in the country.
Guadalajara	Population: 4.374.721; Pop. density (people/km ²): 7.896 The second largest metropolitan area in the country has an exemplary multimodal public transport system, provided by a unique authority. This authority manages the metro system, the BRT system, and the pre-train system.	The organized public transport system collides with a weakly regulated private bus system, a high rate of auto ownership, and a practically non-existent bicycle network.
Lima	Population: 8.482.619; Pop. density (people/km ²): 11.528 Its metropolitan area is composed of more than 40 municipalities, and without any clear administrative framework, efforts to coordinate the actions of these municipalities in improving metropolitan policies have not been very successful.	Lima could be considered as an example of the outdated ‘predict and provide’ approach to urban transport policy; with vast and expanding highways, and insignificant piecemeal reforms to its transport system.
Montevideo	Population: 1.325.968; Pop. density (people/km ²): 6.509 Montevideo consistently ranks as providing the highest quality of life in Latin America. It profits from a fully integrated public transport system, based in ordinary buses.	Montevideo’s transport system is generally regarded as efficient. However, recent efforts have concentrated on diversifying away from bus service provision and into more alternative policies, such as biking, walking, and incentives against the use of the private car.
Caracas	Population: 3.140.076; Pop. density (people/km ²): 12.030 A guiding characteristic of the transport system in Caracas is the absurdly low cost of gas. At US\$0.12 per gallon, it is said to be the cheapest gas in the world. This has important connotations on the structure of the system, as the relative transport costs are significantly lower for car travel.	A highly subsidized Metro system competes with the well-maintained network of inter-urban highways, which are usually clogged. The efforts of the municipalities are often blocked by regional and national political dynamics, making this a very interesting case for research.
Santiago	Population: 6.038.971; Pop. density (people/km ²): 8.814 Its metropolitan area is composed by 34 communes, each with	Previously famous for its dense car traffic and air pollution,

	elected mayors and council members. This political coexistence continues to create serious problems of coordination within the metropolitan area	Santiago has recently implemented sustainable transport policies notorious for the intense political struggles framing its implementation.
Medellín	Population: 3.500.000; Pop. density (people/km ²): 6.920 Medellín's metropolitan area is comprised of 10 autonomous municipalities. The particularities of its geography (fully established within a natural valley), make it vulnerable to environmental threats.	Only Colombian city with a Metro system; a respected transport institution in Latin America. The city also leads the use of cable cars in public transport.

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