Household spending on transport in Latin America and the Caribbean: understanding transport expenditure patterns.

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Abstract

In Latin America and the Caribbean (LAC), transportation constitutes one of the major items in the basket of goods and services consumed by households, accounting for around 12-17% of total expenses. Despite its importance, it is surprising the lack of evidence on transport expenditure patterns in the LAC region. This paper describes household spending on transport in the region, paying special attention to its evolution and differences explained by gender, age and income levels. Engel curves are estimated to understand the relationship between transport spending and changes in household income. Using income and expenditure surveys from 2003 to 2014 in 12 LAC countries – Bahamas, Bolivia, Brazil, Chile, Costa Rica, Ecuador, Honduras, Mexico, Nicaragua, Panama, Paraguay, and Uruguay – this paper finds a notable heterogeneity in transport spending in LAC and a region wide growth in private transport spending at that period. Results show that female head households tend to spend relatively less in private transport and that transport spending inequality is larger than total expenditure inequality proving that demand for private transport grows fast with income. Given that in LAC private transport tends to be a "luxury good" (demand increases more than proportionally than income), policies based on prices (such as congestion pricing or gasoline taxes) could be less effective than quantitative restriction policies when the policy objective is to reduce the growth of private vehicle ownership and use.

Keywords: transport spending, income elasticity, Engel equations, Latin America, Caribbean.

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1. Introduction

Transport has affected economic development from the beginning of human civilization (Lawrence et al., 2011). The academic literature reflects a widespread consensus in the crucial role of transport in accelerating the development process (Hoyle, 1973; Hilling, 2003; among others).

Following Rodrigue et al. (2017) taxonomy, the economic importance of the transport sector can be assessed from both macroeconomic and microeconomic perspectives: at the macroeconomic level, transport has, for a long time, become a sector in itself and national accounts report its size and level of output, employment, and value added within a national economy. In the developing world, transportation represents between 6 and 12% of the GDP and up to 25% when accounting for logistics costs (Rodrigue et al, 2017).

At the microeconomic level, transportation is related to the producer[4] (transport supply) and the consumer (transport demand). From a demand perspective, transport demand constitutes a derived demand, that is, derived from the human desire and need to participate in activities and consume goods and services distributed in time and space (Ferdous, 2010). Commuting is necessary from an economic and social perspective: mobility related to employment, education, and health care is key to alleviating poverty and social exclusion in low-income urban areas (Kenyon et al., 2002; Preston and Rajé, 2007; Lucas, 2012; Garsous et al., 2017). Measuring and understanding the transport expenditure patterns of households and individuals is critically important for formulating public policies that not only directly impact the transport sector but also interplay with other economic sectors. An example in case is housing and location of firms. Availability and affordability of the different transport modes are variables that have increasing weight in the planning process of cities and individual location decisions of firms and households (Salvesen and Renski, 2002; Glaeser and Kohlhase, 2004; Montgomery and Curtis, 2006; Karash, 2008; Olaru et al, 2011).

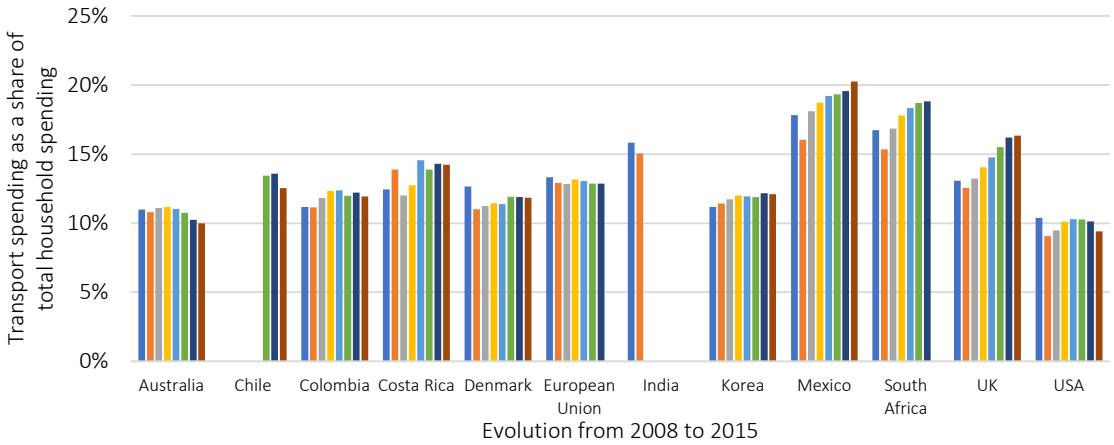
Figure 1 shows that transport spending represents between 10 and 20% of total household spending worldwide. When it comes to the developing world, high transport expenditures are of concern because they can compromise a poor household's ability to access needed services and livelihood-enhancing opportunities that can improve living conditions (Gwilliam, 2002).[5] According to the World Bank, Latin America and the Caribbean is the developing region with the highest share of total household spending dedicated to transport (17%, in contrast to 9% in Sub-Saharan Africa, 11% in Eastern Europe and Central Asia, or 5% in South Asia)[6].

[4] According to Rodrigue (2017), transportation accounts for around 4% of the cost of each unit of output in manufacturing, but this figure varies greatly according to subsectors. The present paper focuses on the consumers' perspective. For a detailed analysis of the economics of transport from a supply perspective, see Hensher and Brewer (2000) and Button (2010).

[5] It must be acknowledged that this present paper deals exclusively with the measurement of household spending on transport. Other related topics that affect access to transport services from an economic perspective are: affordability (Serebrisky et al., 2009; Litman, 2013), costs (Limao and Venables, 2001; Glaeser and Kohlhase, 2004), tariffs (Baier and Berrgstrand, 2001), and quality (Paulley et al., 2006; Dell'Olio et al., 2011). While these factors are out of the scope of this analysis, they are complementary determinants.

[6] http://datatopics.worldbank.org/consumption/sector/Transport

Figure 1: Transport spending as a share of total household spending – a sample of countries worldwide.



Source: Authors, and OECD (2017) data.

In Latin America and the Caribbean, transport services constitute one of the major concerns among the population, together with safety and transparency, according to a recent survey taken across major cities in the region (Serebrisky, 2014). The survey found that 44% of the population in the largest cities of the region (a total of almost 30 million out of 67 million) travel 1.5 hours each day, with an economic cost equivalent of 10 working weeks per year per person. According to INRIX Global Traffic Scorecard, cities such as Sao Paulo (Brazil) or Bogota (Colombia) are ranked within the 10th cities with the highest number of hours spent in congestion worldwide.[7] High commuting times in LAC is caused by two facts that: a pervasive low quality of public transport services that feeds a rapid increase in private car ownership that has been helped by the rise in the disposable income of the middle classes (Ferreira et al, 2012). In fact, the region has experienced a boom over the last decade when it comes to private transportation: countries such as Argentina, Brazil, Mexico and Chile went from 186, 121, 165 and 144 cars per 1,000 inhabitants in 2002 to 314, 249, 230 and 275 in 2010, respectively. By 2030, these figures are expected to rise up to 489, 377, 574 and 491, respectively. The average annual growth rate of car ownership in Latin America is relatively much higher than most of the countries worldwide (Roque and Masoumi, 2015). For every child born in Latin America in 2010, 2.5 new motor vehicle registrations were recorded (Hidalgo and Huizenga, 2013).

Given the magnitude of transportation spending in relation to total household spending worldwide, it is not surprising that the study of household transportation expenditure has received much attention (Venter, 2011; Ferdous et al., 2010). However, most studies have focused on a descriptive analysis of transport spending in specific countries – mostly in developed regions. However, no paper has carried out a regional analysis for Latin America and the Caribbean, despite being the developing region where the share of household spending devoted to transport is among the largest.

This paper is devoted to better understanding household spending on transportation in LAC. The purpose of this paper is twofold. The first objective is to describe household spending, and its recent evolution on transport in the region, paying special attention to identifying patterns between public and private transport across the income distribution, gender and age groups. The second purpose is to develop a demand characterization obtained by studying the relationship between household expenditure on transportation and income through the estimation of Engel curves. Results of this

[7] http://inrix.com/scorecard/

exercise are informative of the likelihood that price versus quantity based policies could have on the decision to use public or private transport modes.

The paper is organized as follows. After the introduction, section 2 provides a summary of the international evidence on household spending in transport quantification. Section 3 presents data that is later described in section 4, where special attention is paid to household spending in transport evolution and differences explained by gender, age and income levels. Engel curves are estimated in section 5 to understand the relationship between transport spending and changes in household income. Finally, some policy implications are derived from the results.

2. Quantifying household spending in transport: International evidence

In 1857, Engel formalized the study of demand through the analysis of household expenditure patterns by developing an empirical law relating the proportion of income spent on food. Engel's formulation of a meaningful relationship out of apparently irregular behavior triggered the development of a new type of econometric study, the consumption demand study, which was later applied to agricultural commodities and a range of other goods, including transportation (Nicholson and Lim, 1987).[8]

Since then, a wide range of studies have focused on the analysis of household expenditure on transportation, identifying regular patterns and trends. Most of the studies have focused on descriptive analyses of household spending, rather than applying sophisticated methodologies to understand demand patterns.[9] Historically, household expenditure on transportation has been 10 to 20% of total expenditures worldwide, which is mainly explained by expenditure on private transport–cars, fuel, reparation, and maintenance of vehicles.

In the US, Schanzenbach et al. (2016) find that low-income households today spend a higher share of their budgets on basic needs compared to thirty years ago. The major budget components are defined as housing, food, transportation, health care, and clothing. Also, the authors find that low- and middle-income households gradually decreased their transportation share (from 3.0 to 1.5%) between 1984 to 2014 in favor of other basic needs, such as housing and health care. These changes are largely driven by declining expenditures on vehicle purchases and improvements in the longevity of vehicles. Currently in the US, transportation expenditure accounts for approximately 17% of total household expenditure, where private transport is still responsible for more than 90% of total transport expenditure (US Department of Transportation, 2016).

In the UK, 14% of household spending goes towards transport, and 79% of this spending is on private motoring (RAC, 2007). Spending on transport, as well as on housing and leisure, increased consistently since the 1950s. Also, evidence shows that households in rural areas spend 20% more

[8] For a detailed review on the study of household transportation expenditure, see Nicholson and Lim (1987) and Ferdous et al. (2010).

[9] There are some remarkable exceptions, particularly those applied in developed countries due to data quality. Kishimoto (2017) recently estimated the first analysis of Engel curves for Chinese households' transport demand that explicitly incorporate city-level factors describing processes of urbanization. Ferdous et al. (2010) develop multiple discrete choice, nested, extreme-value models to relate household transport consumption to consumption of other goods by extending discrete choice and random utility frameworks often used to examine transport mode choice. Finally, Mueller et al. (2009) use a Swiss travel behavior census to develop multi-stage consumer decision models with agent-based microsimulation, wherein households with known transport characteristics choose to make new purchases and then among attributes of new vehicles.

on transport than those living in urban areas, which means that rural residents would be hit the hardest by a fuel duty increase.[10]

In Australia, Moriarty (2002) reports that household spending on transportation remained constant over the last decades at the aggregate level – at about 10 to 15% – with a clear predominance of private transport spending. Indeed, by contrasting Australia's figures with OECD countries, the author shows that private transport comprises 80% of total household transport expenses. In Canada, Anowar et al. (2014) also find a relatively stable transportation spending behavior by Canadians over time – currently around 13.9% of total expenditure (85% of which corresponds to private transport spending).

In Europe, Kauppila (2011) shows that household consumption on transport has remained relatively stable in terms of its expenditure share in OECD countries since the 1970s. Households spent on average around 13.5% of their total expenditure on transport-related goods and services. Ownership (and use) of cars is the main driver of household transport spending, accounting for around 80% of all household spending on transport.

In an international comparison among OECD countries, the author finds that there have been only small variations over time in the composition of transport spending in most of the countries. Korea represents the only exception, where rapid motorization of the society provoked a dramatic increase of private transport spending. Eurostat (2016) confirms that currently around 13% of total household consumption expenditures are allocated to transportation.

In China, Nie and Palmer (2016) explain that spending on transportation and communication increased sevenfold over the last two decades compared with a threefold increase in overall household spending. Kishimoto (2017) finds that transportation and communication expenditures in China are slightly elastic with respect to income and that this elasticity increases gradually with income. Median transport expenditure is generally below 5% of total expenditure; only for the highest-spending households does the range exceed 10%.

When it comes to the developing world, although transport costs as a share of household expenditure vary greatly across space and time, overall transport expenditure generally increases strongly with income, but tends to be regressive as transport costs consume a larger share of income among poorer households (Venter, 2011).[11] Indeed, in the case of Pakistan, Burney and Khan (1991) conclude that transportation costs as a whole are a luxury for urban households (based on data from the Household Income and Expenditure Survey).

In Africa, Olvera et al. (2008) find that the percentage spent on transport in African cities ranges from 8 to 15%, based on household expenditure and consumption surveys. Further, the authors find that differences between the transport shares of the poor and non-poor are enormous – 6.7 vs. 13.4%, respectively. In South Africa, Venter (2011) concludes that that a person's location along the urban-rural continuum significantly affects both their transport expenditure levels and the perceived

[10] Interestingly, several studies have found that the short-run price elasticity of fuel has decreased considerably over time (Hughes et al., 2006; Small and Van Dender, 2007). Ferdous et al. (2010) summarizes the research on the relative inelasticity of demand to fuel price increases.

[11] In his study, Venter (2011) discusses how in many cases poorer households pay more (in absolute terms) for public transport trips than their richer counterparts do. The likely reasons for this stem from the poor location of many low-income households in the urban periphery, where low demand and long travel distances push up fares (Gannon and Liu, 1997) as well as a high dependence on informal transport modes with unsubsidized fares (Diaz Olvera et al., 2008).

severity of their transport affordability problems.[12] Among the lowest three income quintiles, transport comprises around 12% of all consumption, but this rises to 24% for the richest households. A large part of the difference is due to the higher use of the (more expensive) private automobile among higher income groups. However, as incomes rise much faster than total consumption, the share of income going towards transport in South Africa is much higher among the poorest fifth of households (21%) than among higher income households (12 to 16%).

Given that transportation accounts for nearly 20% of total household expenses and 12 to 15% of total household income worldwide, it is no surprise that the study of transportation expenditures has been of much interest (Ferdous et al., 2010). However, there is little knowledge regarding transport expenditure in Latin American and Caribbean households and the characteristics of that spending. The small amount of available information that does exist on the region is focused on descriptive analysis of household spending in transportation, with the most remarkable examples being the studies by Bernal and Garzon (2010) in Colombia, and Gartner et al. (2011) in Argentina. Nevertheless, there is no regional paper prior to the present one that analyzes household expenditure in transport in Latin America and the Caribbean.

3. Data from income and expenditure surveys

Countries perform income and expenditure surveys at least every decade or so as an input for the Consumer Price Index (CPI). Since the objective of the surveys is the construction of an average consumption basket, data on consumption expenditure is thoroughly disaggregated, including all forms of consumption, such as food, beverages, leisure, health, education, and transportation expenditures. This paper uses micro data from 2003 to 2014[13] for the following 12 LAC countries: Bahamas, Bolivia, Brazil, Chile, Costa Rica, Ecuador, Honduras, Mexico, Nicaragua, Panama, Paraguay, and Uruguay. Survey coverage includes representative samples from urban areas. Table A1 in the Annex presents the data sources.

The surveys use two types of recollection mechanisms to gather expenditure information: diaries and interviews. Both mechanisms are used in Brazil, Chile, Costa Rica, Mexico, Panama, and Uruguay. The rest of the countries in LAC only use an interview to collect data on expenses. In the interviews, interviewers ask about substantial and also high-value expenses that are assumed to be correctly estimated by household members. In contrast, diaries are used to collect information on households most frequent small expenses, generally over a seven-day period. In some cases, there are two diaries: one to compute household expenses and another for each household member to compute their personal expenses. The two-diary system is used in Chile, Costa Rica, Panama, and Uruguay, while in Mexico and Brazil only the household diary is used.

The surveys request expenditure information over various time frames. There are differences in time frames both within and between surveys. Using the two data-gathering instruments discussed

[12] The author finds that public transport users in displaced urban settlements , isolated deep rural locations, as well as medium-income car commuters in suburbs and urban townships face the highest transport expenditures and affordability problems.

[13] As Table A1 in the Annex shows, we do not have information for the same years for each country. Ideally, we would like to have information for all at the same moment in time and in the same phase of the business cycle. This is not possible when considering a large sample of countries.

above, expenditures are usually amassed for the following periods of time: i)7 days, ii) 30 days, iii) 90 days, and iv) 12 months. Usually, the 7-day time frame is used for food and cleaning item expenses, and the 30-day time frame collects information on expenses, such as clothes and transportation. The 90-day time frame collects information on expenses, such as maintenance of household equipment, and the 12-month time frame usually gathers information on durable goods and on educational and housing expenses. We convert all figures into annual data.

In this paper, expenditure is defined in a broad sense and includes all forms of consumption. The microdata provides spending with a large degree of disaggregation. We aggregated items to construct homogenous categories. The broader category reflects total transportation spending. It can be divided into spending on private means and public means of transportation. Private transport is also divided into smaller categories: i) spending on cars, ii) spending on two-wheel vehicles, iii) fuel expenditure, and iv) other private transport costs (insurance, registration certificates, maintenance, etc.). Public transportation is divided into: i) buses, metros, and other shared means of transportation, ii) taxis, remises, and other means of non-shared transportation, and iii) other forms of public transport.

4. Describing household spending on transport in LAC

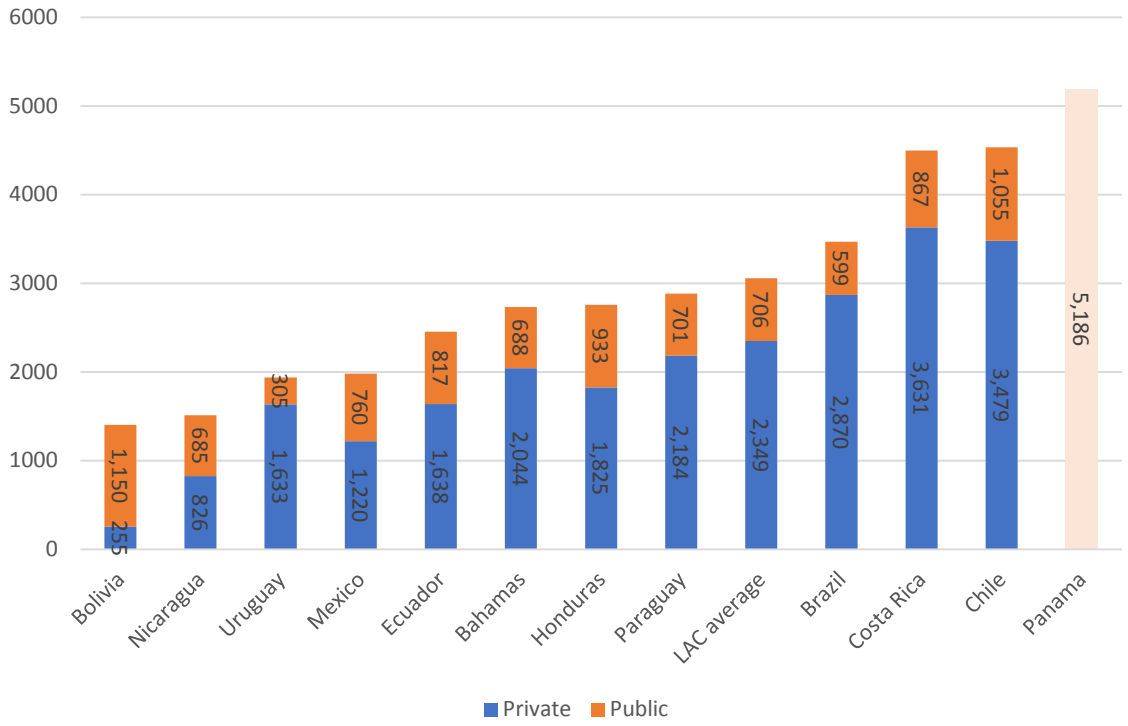
As reported in Figure 2, LAC annual household average spending on transportation is $3,055 (measured in 2014 Purchasing Power Parity, PPP, adjusted US dollars), which represents 11.8% of total household expenditure. Panama, Costa Rica, Chile, and Brazil are the countries with the largest transportation spending while Bolivia, Nicaragua, and Uruguay are the countries with the lowest transportation spending. [14]

Household spending on private transportation accounts for around 76% of total expenditure, while spending on public transportation accounts for the remaining 24%. This pattern of much higher spending on private means of transportation compared to public transportation is present in all countries in the region. Hence, the LAC average relationship between spending on private vs. public transportation is 3 to 1, but this statistic hides huge disparities among countries such as Bolivia, where spending on public transportation is 3 to 4 times higher than spending on private

[14] Results may vary slightly depending on the precise definition of the ratios. In the Annex, Panels B1-B3 in Figure A3 represent the average of household's shares (ratio of transportation spending to total household expenditure that may be 0 for many households). Panels C1-C3 in Figure A3 present the ratio of country spending on transportation to total country expenditure. The B Panels are an average of ratios defined at the household level while the C Panels are the ratio between the absolute levels (in PPP adjusted US dollars) of national transport spending to national total expenditure (it is a ratio of averages). According to Panel B1, transportation spending accounts for 11.8% of total expenditure for the average LAC household. According to Panel C1, this figure is 14.1%. At this point it is worthwhile to note the difference between the average of ratios and the ratio of averages. While they are along the same lines, they do not report the same information. The average of ratios gives the same weight to each household, while in the ratio of national averages the rich account for a larger part of the denominator. If the rich spend a higher share of their budget on transportation than the poor, then the ratio of average transportation spending to average total spending will be higher than the average of household ratios. That is why the average LAC value suggested for spending on private transportation is larger in Panel C (10.8%) than in Panel B (6.7%), and the opposite happens for spending on public means of transportation (3.2 vs. 4.9%, respectively).

transportation. In contrast, in Uruguay, Costa Rica and Brazil, spending on private transportation is 4 or 5 times higher than that on public transportation.

Figure 2: Average household spending on transport by country, 2014 PPP adjusted dollars – Public and Private



Note: Panama data cannot be disaggregated between public and private.

Table A2 in the Annex presents a disaggregation of average transport spending on its main public and private components. Spending on cars is the most important form of spending in the private means of transportation category, representing an annual spending of US$1,436. Fuel expenditures is the second item of importance with an average annual spending of US$836. These top two categories represent 45% and 26% of total transportation expenditure, respectively. With respect to public transportation spending, average spending on buses, metro, and other shared means of transport represents about 20% of total transportation expenditure.

The rich data set being employed here allows us to look for trends and patterns in household expenditure in transportation. The rest of this section analyzes the relationship between household expenditure in transportation and income, inequality, gender, age, and time evolution.

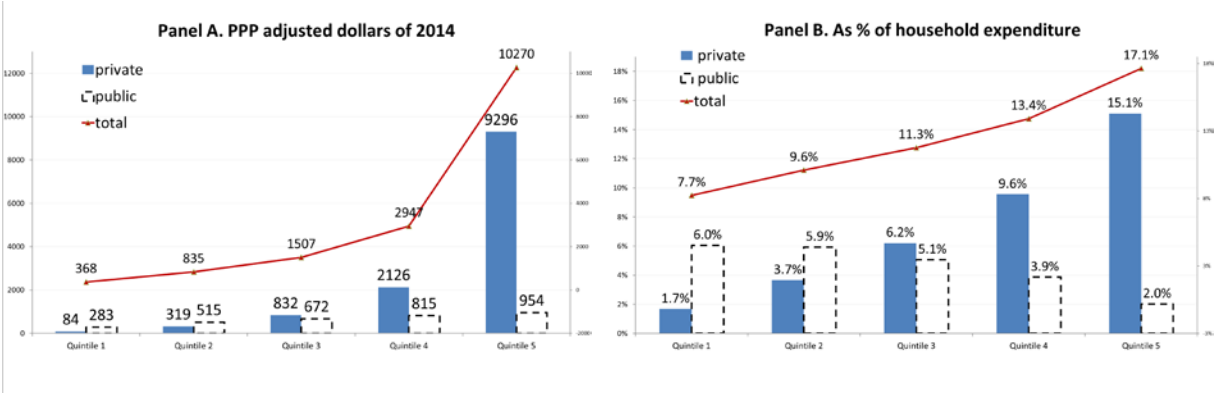
a. In LAC, is public transport for the poor?

It is natural to think that the rich spend more in absolute levels on almost everything, but whether they spend a larger proportion of their budget on transportation is less obvious, and the international evidence shows some heterogeneity.[15] One should expect that some forms of public transportation, for instance buses, may be more widely used by poorer individuals than by richer ones, as individuals in the latter income class typically own their own means of transportation,

[15] http://datatopics.worldbank.org/consumption/sector/Transport

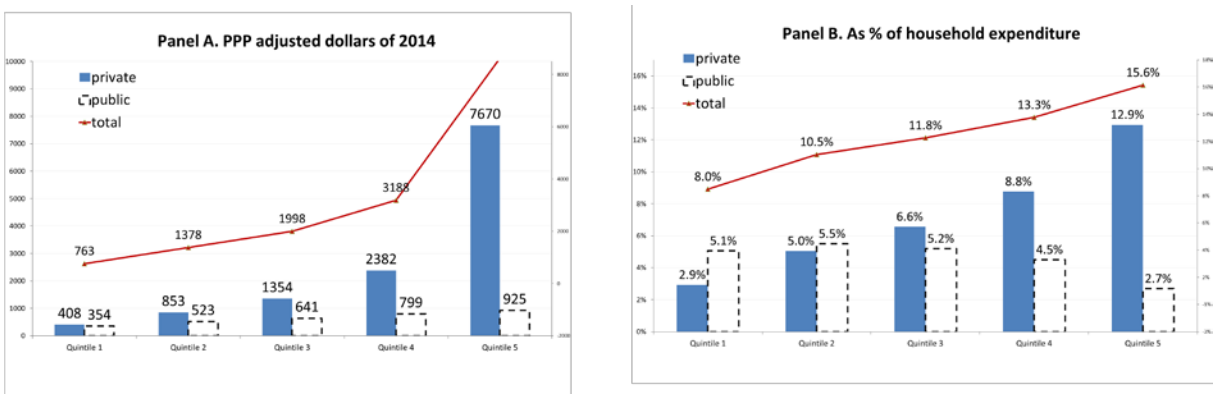
implying that the allocation of the transportation budget may vary among income groups.[16] Figures 3 and 4 (reporting transportation expenses by expenditure and income quintile, respectively) show differences between the rich and poor at absolute and relative levels. With respect to total transportation expenses in LAC, the top expenditure quintile spends 26 times more than the first quintile. The forth quintile total transportation spending is over 3 times that of the second expenditure quintile. In terms of shares, the differences are much smaller: transportation spending by the top expenditure quintile represents 17.1% of its total expenditure while it represents 7.7% of consumption in the poorest quintile.

Figure 3: Average household transportation expenses by expenditure quintile, LAC average



[16] The terms "rich" and "poor" are widely used in the related literature when it comes to the analysis of household savings and spending behavior (for instance Gandelman 2017 and Acerenza and Gandelman 2018a).

Figure 4: Average household transportation expenses by income quintile, LAC average



In monetary terms, richer households spend more on private and public means of transportation. Nevertheless, this same pattern is not observed in terms of shares. While the share of spending on private transportation relative to total expenditure is higher for the rich than the poor, the opposite occurs with respect to the share of spending on public transportation. Households in the bottom expenditure quintile only allocate 1.7% of their total expenditure to private means of transportation. In contrast, households in the top expenditure quintile allocate 14.1%. Contrarily, households in the first expenditure quintile allocate 6.2% of their expenditure budget to public transportation while households in the top quintile allocate 2.5%.

If the expenditure elasticity of transportation is 1, it must be that an increase of *x* percent in total expenditure translates into an increase of *x* percent in transportation expenditure. If this is the case, the ratio of transportation expenditure to total expenditure should be constant. The data in Figures 3 and 4 suggests that expenditure elasticity for private transportation is above 1 (a luxury good) while the elasticity for public transportation is below 1 (a necessity). This is formally tested through the estimation of Engel curves in the next section.

The data also reveals a sizeable difference in mean and median values of household transportation expenditures among individual LAC countries (see Table A4 in the Annex). Country means are 2 to 3 times larger than the country medians (as LAC spending in the average household is 175% larger than the spending of the median household). This suggest a right-skewed expenditure distribution. Our estimates of Gini coefficients based on total expenditure show lower levels of inequality than the income-based Gini coefficients. This is consistent with the evidence that saving rates are higher in the top of the income distribution (see Gandelman, 2017). In addition, our estimates of Gini coefficients based on income are consistent with those published in the World Bank report, World Development Indicators. This consistency with WDI figures is a check of the reasonability of the results reported as well as the quality of the data.

We find that in LAC, the inequality in transportation spending is larger than the inequality in total expenditure. The Gini based on transport spending (0.719) is 43% larger than the Gini based on total expenditure (0.502).[17]

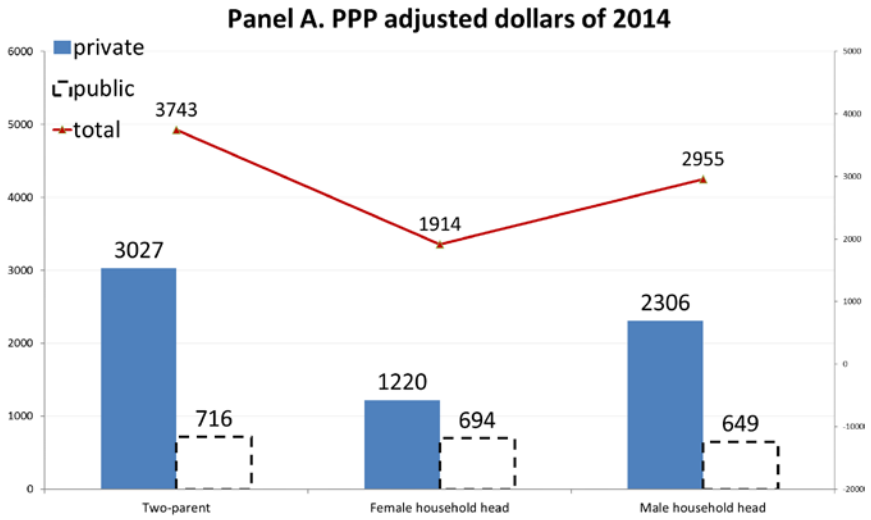
[17] This difference in inequality between total consumption and transport sector consumption is somewhat expected. It is interesting to note that it is also reported, with much larger differences, in Acerenza and

b. Is there a gender bias in transport spending?

Family structure can influence budget allocation, including on transportation spending. Babinard and Scott (2011) argue that women tend to have less access to cars, and in households where there is a private car, men usually get priority for its use. The lack of access to private transportation by women is to some degree the consequence of a lower travel frequency and shorter distances traveled than men (Babinard and Scott, 2011; Anand and Tiwari, 2006).[18]

To analyze the relationship between household spending on transport and gender in LAC, we use the subsample of households that have at least one child. We divide households by those with two parents present and households with a single parent. Within the latter group, we differentiate between female-headed households and male-headed households. Figure 5 presents the results.

Figure 5: Average household transportation expenses by type of family structure in LAC



Interestingly, the three types of households spend a very similar amount on public transportation (around US$700), but there are larger differences in spending on private transportation. This is likely associated with the different income levels of households. Two-parent families tend to be richer and spend about US$3,027 on private transportation, which is about a third above male-headed household, which spend US$2,306. Both household types far outspend on private transportation as compared to female-headed households, which average US$1,220. In single parent households, when the household is led by a woman, the expenditure on private transportation represents 7% of total spending well below the 11% budget allocation made by men single parents. In contrast, public transport expenditure remains gender neutral (3% and 4% of total spending respectively). Our results refer to between-households gender differences and do not consider within-households

Gandelman (2018a) for household educational spending and even larger than that for cultural spending in Acerenza and Gandelman (2018b).

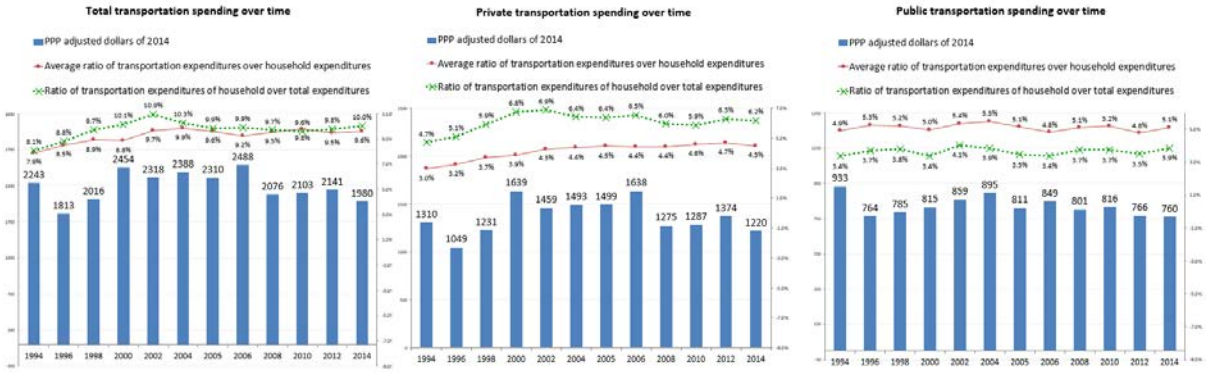
[18] As an example, Odufuwa (2007) shows that, for the case of Nigeria, the decision to buy a car was made by the husband in 59% of households. In Pakistan, Adeel et al. (2017) also mention the significant influence of social and cultural factors on female mobility. The authors find that the trip rates of men do not change significantly with household income, while those of women decrease by 14% between the lowest and highest income quintiles. However, the mean daily travel duration among men increases by 6% between the lowest and highest income quintiles but remains unchanged among women.

biases. As such, they should be considered a lower bound on how household spending on private transport in Latin America and the Caribbean is gender biased. This result is in line with evidence observed in other countries in the developing world (Odufuwa, 2007, Babinard and Scott, 2011)

c. Transport spending over time and throughout the life cycle: The case of Mexico

Time evolution cannot be analyzed for most countries in the sample due to data availability. However, Mexico´s income and expenditure surveys are reported every two years. Figure 6 shows the evolution of total transport spending in Mexico over a twenty-year period from 1994 to 2014. Also reported is the spending in monetary terms as the average of household shares and as the share of national transportation spending to national household expenditure.

Figure 6: Transportation spending over time in Mexico



The shares of public transport spending are roughly constant over time. This is somewhat expected given transportation behavior changes slowly.[19] The data also reveals that the shares of spending on private means of transportation are highly correlated with per capita GDP. The estimated Pearson' correlation of 0.74 is statistically significant at 1%. The correlation between per capita GDP and the share of spending on public means of transportation is negative but not statistically significant. The net effect of the positive correlation with private transportation spending and the negative (o null) correlation with public transportation spending generates a positive (0.49) correlation between per capita GDP and the share of transport spending relative to total expenditure but marginally below the traditional statistical significance threshold of 10%.

Besides that, there seems to be a systematic increase in the share of spending on private transportation in Mexico that is not present in spending on public transportation. In fact, when decomposing by income quintile, we found that this trend is explained by the fact that low- and middle-income households have gradually increased spending on private transportation. The first quintile doubled spending on private transportation in 20 years, while the 2nd-4th quintiles increased private transport spending by more than 55% during that period (Figure A5 in the Annex). In terms of 2014 PPP adjusted US dollars, public transportation spending in Mexico has decreased over the last two decades for all income quintiles. These results are in line with the huge increase in the

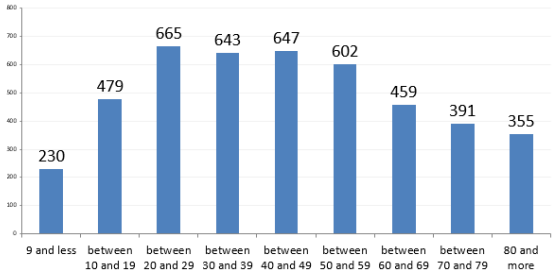
[19] See footnote 10 for a discussion of the two forms of ratios computed and how the change according to how much the poor and rich spend on different goods").

number of vehicles in the country, which has doubled over the last ten years (INEGI, 2017). Mexico City alone experienced an increase of 159% in the number of vehicles during that period.

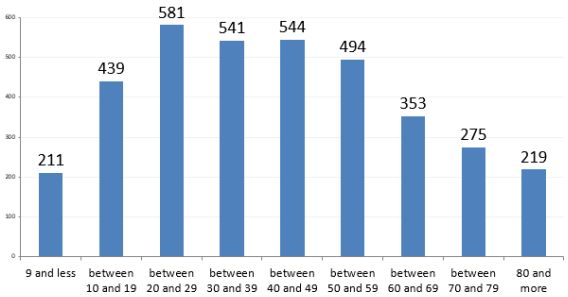
Indeed, the needs for personal mobility change through life. The vehicles used for this mobility also change through life. Is public transport for young people? Do the elderly widely use public transport in LAC? It is interesting to analyze patterns of transportation spending over the life cycle. Ideally, to obtain an estimation of this sort it would be necessary to use panel data to follow the same individuals over time, but this data is not available. An alternative is to study cross section data. Unfortunately, this cannot be done for most countries since transportation spending is reported only at the household level, Mexico being an exception. Data from Mexico allows us to observe differences in public transportation spending over the life cycle. Results show that people between 20-29 years of age represent the group that spend the most on public transportation. Spending on public transport gradually decreases with age.

Figure 7: Transportation spending over the life cycle in Mexico

Panel A. Spending in public means of transportation.



Panel B. Spending in bus.



5. Engel curves for household expenditure on transport

The analysis of household expenditure patterns by sector dates from the 19th century. The seminal work came from Engel (1857), with the analysis of food elasticity to income and later commodities. The first household expenditure studies on transport date from the mid-1900s.[20] Estimations of Engel curves for several goods and services have been intensively performed in microeconomic applied research since Working (1943) and Leser (1963) uncovered the stability of the relationship between the expenditure share of food consumption and the logarithm of income. Later research has permitted functional forms beyond the linear specification that allow for more curvature than the Working-Leser model.

The basic analysis of Engel curves starts from the definition of relatively homogeneous demographic groups to which various estimations techniques can be applied (e.g., kernel regressions, pointwise confidence intervals).[21] The standard Working-Leser specification is:

$$w_i = \alpha + \beta ln\left(\frac{x_i}{n_i}\right) + \gamma lnn_i + \varphi z_i + \mu_i \qquad (1)$$

where w_i is the budget share of transportation of the i[th] household, x_i is the total expenditure of the household, n_i is the household size, z_i is a vector of other household socio-demographic

[20] Prais and Houthakker (1955) and Oi and Shuldiner (1962). For a detailed analysis of the application of household expenditure analysis to the transport sector, see Nicholson and Lim (1987) and Ferdous (2010).

[21] See Blundell (1998) for a nice review of the development of the literature on consumer demand and household intertemporal allocation.

characteristics, such as education and gender of the household head and a dummy variables for region of residence[22]. μ_i is the error term.

The expenditure elasticity of transportation spending is $= 1 + \frac{\beta}{w_i}$. This functional form allows the elasticity to vary by the share of transportation expenditure but does not allow the good to be a necessity ($\beta < 0$) for some households and a luxury ($\beta > 0$) for others.

Equation (1) can easily be relaxed to allow for nonlinearity in log per capita expenditure including quadratic terms as in Banks et al. (1997).

$$w_i = \alpha + \beta ln\left(\frac{x_i}{n_i}\right) + \lambda\left[ln\left(\frac{x_i}{n_i}\right)\right]^2 + \gamma lnn_i + \delta lnP_j + \varphi z_i + \mu_i \quad (2)$$

The expenditure elasticity in this case depends on the transport share and on the level of total spending: $1 + \frac{\beta+2\lambda lnx_i}{w_i}$. The joint estimation of β and λ allow changes in the classification of goods (necessity or luxury) for rich and poor.

The initial estimations of Engel equations were performed for food expenditure simply using an Ordinary Least Squares (OLS) estimator. For other types of expenditure, including transportation, there is the problem of a substantial number of zero expenditure entries. The solution in the present paper for this censoring problem is to estimate using a Tobit model.

In transport economics, most studies so far have focused on single goods or services (most prominently gasoline) and have not taken an encompassing view of total transportation expenditure (Dahl and Sterner, 1991; Graham and Glaister, 2002; among many others). Additionally, there is a notorious lack of multi-country comparisons that are useful to establish benchmarks and assess robustness of methodologies and results. As previously discussed, there are only a few studies based on expenditure data for individual LAC countries.

a. Estimating Engel curves for LAC countries: Inferior, necessity, and luxury transport goods and services

Engel curves have been estimated for transport goods and services in LAC. The household budget share of transport goods and services is regressed on the log of per capita total expenditure, log of household size, shares of various age-gender groups, and other household characteristics. Table 1 presents the results of the Tobit model.

[22] We do not have information on prices so this is a source of potential omitted variable bias. Assuming households within regions face the same set of prices location dummies should reduce this problem since all consumption differences due to common regional prices is translated into fixed effects. In our estimations we include about 200 regional dummies.

Table 1. Engel regressions (Tobit estimations)

	Total Transport Spending (A)	Public means of transportation (B)	Private means of transportation (C)	Bus, metro, etc. (D)	Fuel (E)
Per capita expenditure (in logs)	0.05152***	-0.01975***	0.11740***	-0.02191***	0.05021***
	(0.00170)	(0.00118)	(0.00240)	(0.00122)	(0.00135)
Age of the household head	-0.00094***	-0.00035***	-0.00080***	-0.00040***	0.00039***
	(0.00009)	(0.00006)	(0.00013)	(0.00007)	(0.00009)
Household head education=secondary incomplete	0.01182***	0.01544***	0.00866**	0.01697***	0.01955***
	(0.00247)	(0.00198)	(0.00388)	(0.00204)	(0.00281)
Household head education=secondary complete	-0.00974***	-0.00734***	0.00320	-0.00790***	0.03661***
	(0.00355)	(0.00257)	(0.00520)	(0.00264)	(0.00345)
Household head education=tertiary	-0.02487***	0.01402***	-0.07040***	0.01359***	-0.04937***
	(0.00218)	(0.00165)	(0.00347)	(0.00170)	(0.00235)
Household members (in logs)	0.05503***	0.00718***	0.10822***	0.00791***	0.04361***
	(0.00218)	(0.00167)	(0.00328)	(0.00172)	(0.00208)
Regional dummies	Yes	Yes	Yes	Yes	Yes
Observations	117,754	109,818	109,818	109,818	109,818

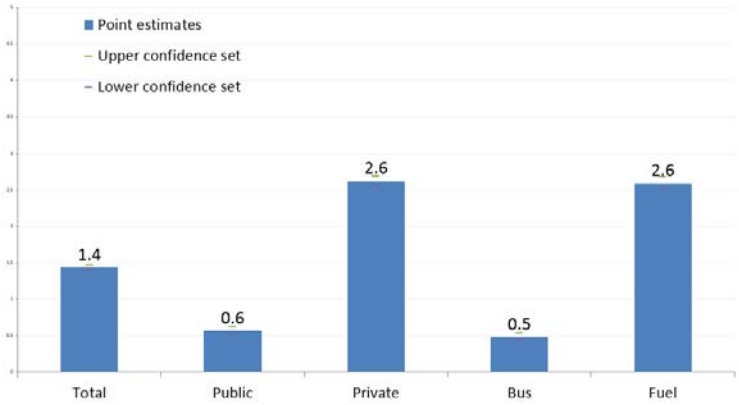
Robust standard errors in parentheses. *** statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%.

Columns A to E in Table 1 presents the results of estimating equation (1) using a pooled sample of LAC countries for total transportation spending, spending on public transportation, spending on private transportation, spending on buses, metros, and other shared means of transportation, and spending on fuel.

The estimated coefficient for expenditure per capita in columns A, C, and E is positive implying that overall transportation, private transportation, and fuels have an expenditure elasticity above 1 (luxury good). On the other hand, the coefficient for columns B and D is negative suggesting that public transportation as well as bus, metro, and other shared means have an expenditure elasticity below 1 (necessary good).

Based on equation 1, Figure 8 presents the expenditure elasticities valued at the mean of the respective transportation spending share. In the estimations using all LAC countries we find an expenditure elasticity of 1.4 for overall transportation. This hides the different characteristics of private vs. public transportation. The expenditure elasticity of public transportation is 0.5, a necessity. On the other hand, the expenditure elasticity of private transportation spending is 2.6, a luxury. The confidence intervals show that the estimation is rather precise, so we can reject the null of unitary elasticity in both cases.

Figure 8: Expenditure elasticities of transport in LAC



The elasticity of bus spending and fuel spending behave similarly to public and private transportation, respectively. Bus, metro, and other shared means of public transportation are necessity goods with an expenditure elasticity of 0.6, while spending on fuel is a luxury with an expenditure elasticity of 2.7.

Figure A6 in the Annex presents expenditure elasticities by country. Since Brazil and Mexico are the largest countries in our sample it is no surprise that the LAC result mirrors them quite closely given their larger weight in the regressions. The elasticity of total transport spending in LAC ranges between 1.1 for Bolivia and 1.9 for Uruguay. In all cases, we reject the null of unitary elasticity, thus, transport is considered a luxury good. The expenditure elasticity of household spending on public transportation is below 1 for most LAC countries, with point elasticities above 1 only for Honduras, Uruguay, and Bahamas. On the other hand, the elasticity of households spending on private transportation is above 1 for all countries, ranging from 1.8 for the Bahamas to a huge 9.0 for Bolivia.

Table 2. Engel regressions (Tobit estimations with more curvature for total spending)

	Total transport spending (A)	Public means of transport (B)	Private means of transport (C)	Bus, metro, etc. (D)	Fuel (E)
Per capita expenditure (in logs)	0.13971***	0.06815***	0.36013***	0.08040***	0.35834***
	(0.01838)	(0.01436)	(0.02185)	(0.01527)	(0.01423)
Per capita expenditure squared (in logs)	-0.00513***	-0.00518***	-0.01386***	-0.00604***	-0.01745***
	(0.00107)	(0.00082)	(0.00125)	(0.00088)	(0.00079)
Age of the household head	-0.00096***	-0.00036***	-0.00087***	-0.00041***	0.00032***
	(0.00009)	(0.00006)	(0.00013)	(0.00007)	(0.00009)
Household head education=secondary incomplete	0.01064***	0.01440***	0.00497	0.01582***	0.01483***
	(0.00248)	(0.00199)	(0.00390)	(0.00205)	(0.00283)
Household head education=secondary complete	-0.00707**	-0.00405	0.00713	-0.00406	0.03922***
	(0.00352)	(0.00253)	(0.00510)	(0.00260)	(0.00334)
Household head education=tertiary	-0.02469***	0.01415***	-0.06987***	0.01376***	-0.04864***
	(0.00216)	(0.00166)	(0.00342)	(0.00170)	(0.00230)
Household members (in logs)	0.05561***	0.00756***	0.10978***	0.00832***	0.04516***
	(0.00216)	(0.00168)	(0.00321)	(0.00173)	(0.00202)
Regional dummies	Yes	Yes	Yes	Yes	Yes
Observations	117,754	109,818	109,818	109,818	109,818

Robust standard errors in parentheses. *** statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%.

Table 2 reports the results for equation (2). In the five regressions considered, the linear term is positive and the squared term negative. At least for the poorest households, the share of spending on transportation is increasing with total expenditure but at a decreasing rate. Eventually, the negative estimated coefficient associated with the square term dominates, implying that increases in household total expenditure are associated with lower shares of transportation spending. This happens in all five regressions but at very different levels. According to the estimated coefficients, the maximum share in private transportation occurs for households with per capita incomes close to US$400,000 On the other hand, the maximum share in public transportation takes place for households with per capita income of about US$500. In practical terms, for the LAC population, the share of spending on private means of transportation is always increasing with total expenditure, but spending on public means of transportation has a different relationship, depending on income.

This suggests that it could be useful to allow for different elasticities among the poor and rich. To do so we divide the population between those in i) the first expenditure quintile, ii) the second to fourth quintile, and iii) the fifth quintile. We refer to them as the poor, the middle sectors, and the rich. This is done country by country so that when we compute the results for LAC we always have the poorest 20% of each country among the LAC poor. In this way, we are certain that differences in elasticities between groups of the population are indeed that and not country effects.

Figure 8: Expenditure elasticities of transport in LAC, by expenditure quintile

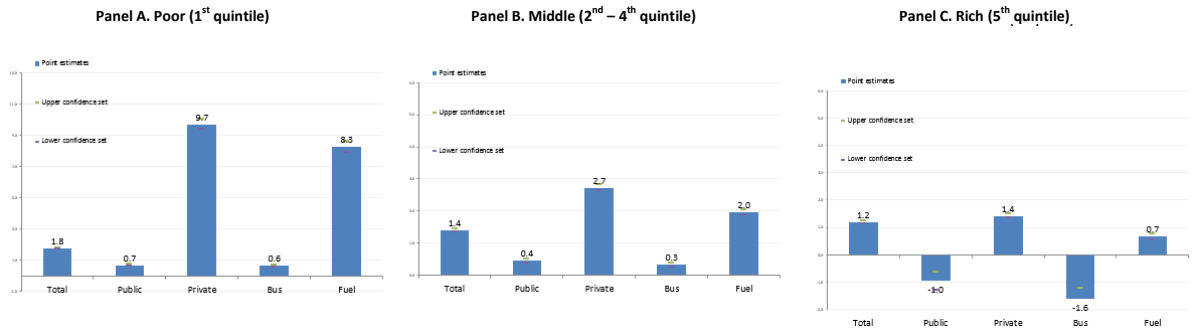


Figure 8 presents these expenditure elasticities for LAC. The results for the middle sectors are very similar quantitatively to the results for the region. The expenditure elasticity of total transport for this group is 1.4, but it hides a lower elasticity for spending on public transportation (0.5) and a larger elasticity for spending on private transportation (2.9). For the middle sectors, public transportation is a necessity while spending on private transportation, including fuel spending, is a luxury.

Panel A above depicts the elasticities for the poor, which are similar qualitatively to the middle sectors but with larger elasticities for household spending on private transport. For the poor in LAC, private means of transportation are a huge luxury. Understandably, fuel elasticity for the poor is also a luxury. Panel C shows the elasticity for the rich. Spending on public transport overall and in the bus, metro, etc. category has a negative (-0.8 and -1.4, respectively) expenditure elasticity. This means that for the rich, public transportation is an inferior good. When the household expenditure budget increases, this translates into lower absolute spending on public transportation. On the other hand, fuel elasticity for the rich is below 1, as fuel spending for the rich is a necessity. In sum, the comparison of elasticities between groups within the population in LAC has shown some interesting facts. Public transportation is a necessity for the poor and the middle sectors, but it is inferior good for the rich. Fuel transportation is a luxury for the poor and the middle sectors, but it is a necessity for the rich.

6. Policy implications: The need for quantitative restrictions on private transport in LAC

While transport is a major consumption item for LAC households – and its importance for the regional economy is widely acknowledged – little had been said on the more detailed composition of transport expenditure across household types by socio-economic categories. Using income and expenditure surveys from 2003 to 2014 in 12 LAC countries – Bahamas, Bolivia, Brazil, Chile, Costa Rica, Ecuador, Honduras, Mexico, Nicaragua, Panama, Paraguay, and Uruguay – the present study finds a huge heterogeneity in transport spending in the LAC region, with some countries spending even 5 times more than others.

The descriptive analysis shows that most transportation spending is dedicated to private means of transport: the average LAC household spends three times more on private than public transportation. Private transport, as a share of total expenditure, is constantly increasing, especially in low- and middle-income households, while the public transport share remains constant. The data

examined reveals that transport inequality is larger than total expenditure inequality. Also, the results confirm that household spending in transport is gender biased in Latin America and the Caribbean: there is a need for policies to promote the role of women in the household decision-making process when it comes to transport.

The Engel curves analysis undertaken proves that public transportation is a necessity for the poor and middle-income sectors, but it is an inferior good for the rich in Latin America and the Caribbean. Conversely, fuel transportation is a luxury for the poor and middle sectors, but it is a necessity for the rich. Unless a structural change occurs, the rapidly increase of motorization levels – car ownership annual growth rate in LAC countries ranges from 4.4% in Argentina to 5% in Brazil and Mexico or 6.1% in Chile, compared to those in the USA (1.1%), the European Union (around 1%), Australia (0.7%) or Japan (0.6%) (Roque and Masoumi, 2015) – implies that current mobility issues in the region will exacerbate in the future.

To reduce air pollution and congestion, Latin American cities have experimented with different policies to persuade drivers to give up their cars in favor of public transport (Gallego et al, 2013). The elasticities calculated in our paper suggest that fiscal policy instruments (taxes and charges) to pursue a desired outcome – managing demand, reducing congestion, dealing with emissions, among many other policy goals – may not have the looked-for impact. Instead, quantitative restrictions policies – parking limitations, complete or partial street closures to private transport, and restrictions to access by plate numbers, among others – could become more effective – if properly designed, and controlling for the long-run effect on purchases of additional vehicles – when it comes to the promotion of public transport in Latin America and Caribbean countries.

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Annex

Table A1. Data

	Years	Survey	Source
Bahamas	2013	Bahamas Household Expenditure Survey	Department of Statistics, Ministry of Finance
Bolivia	2003-2004	Encuesta Continua de los Hogares	Instituto Nacional de Estadística
Brazil	2008-2009	Pesquisa de Orçamentos Familiares	Instituto Brasileiro de Geografia e Estatística
Chile	2011-2012	VII Encuesta de Presupuestos Familiares	Instituto Nacional de Estadísticas
Costa Rica	2013	Encuesta Nacional de Ingresos y Gastos de los Hogares	Instituto Nacional de Estadística y Censos
Ecuador	2011-2012	Encuesta Nacional de Ingresos y Gastos de los Hogares Urbanos	Instituto Nacional de Estadística y Censos
Honduras	2004	Encuesta Nacional de Condiciones de Vida	Instituto Nacional de Estadística
Mexico	2014	Encuesta Nacional de Ingresos y Gastos de los Hogares	Instituto Nacional de Estadística y Geografía
Nicaragua	2006-2007	Encuesta Ingresos y Gastos de los Hogares	Banco Central de Nicaragua
Panama	2007-2008	Encuesta de Ingresos y Gastos de los Hogares	Instituto Nacional de Estadística y Censo
Paraguay	2011-2012	Encuesta de Ingresos y Gastos y de Condiciones de Vida	Dirección General de Estadísticas, Encuestas y Censos
Uruguay	2005-2006	Encuesta Nacional de Gastos e Ingresos de los Hogares	Instituto Nacional de Estadística

Table A2. Disaggregation of transport expenses by country

	Private Expenditures					Public Expenditures				
	Spending on cars	Spending on two-wheel vehicles	Fuel expenditure	Other private transport costs	Total private	Buses, metros and other shared means of transportation	Taxis, remises, and other means of non-shared transportation	Other forms	Total public	Total
	Annual average, PPP adjusted dollars of 2014									
Bahamas	566	6	185	1286	2044	579	109	.	688	2731
Bolivia		6	115	133	255	867	283	.	1150	1405
Brazil	1716	205	885	64	2870	542	57	.	599	3469
Chile	1804	56	1031	587	3479	801	244	9	1055	4533
Costa Rica	2018	61	994	558	3631	656	207	3	867	4498
Ecuador	955	54	325	303	1638	615	202	1	817	2455
Honduras	704	38	742	341	1825	695	.	239	933	2758
Mexico	315	11	761	134	1220	672	85	3	760	1980
Nicaragua	258	34	450	84	826	685		.	685	1512
Panamá	.	.	.	.	.	.	.	.	.	5186
Paraguay	790	11	1106	277	2184	672	28	0	701	2885
Uruguay	487	207	564	374	1633	276	29	0	305	1938
LAC average	1436	161	836	98	2531	574	73	8	648	3185

Table A2. (cont)

	Private Expenditures					Public Expenditures				
	Spending on cars	Spending on two-wheel vehicles	Fuel expenditure	Other private transport costs	Total private	Buses, metros and other shared means of transportation	Taxis, remises, and other means of non-shared transportation	Other forms	Total public	Total
	Structure in percentage terms (%)									
Bahamas	21%	0%	7%	47%	75%	21%	4%		25%	100%
Bolivia		0%	8%	9%	18%	62%	20%		82%	100%
Brazil	49%	6%	26%	2%	83%	16%	2%		17%	100%
Chile	40%	1%	23%	13%	77%	18%	5%	0%	23%	100%
Costa Rica	45%	1%	22%	12%	81%	15%	5%	0%	19%	100%
Ecuador	39%	2%	13%	12%	67%	25%	8%	0%	33%	100%
Honduras	26%	1%	27%	12%	66%	25%		9%	34%	100%
Mexico	16%	1%	38%	7%	62%	34%	4%	0%	38%	100%
Nicaragua	17%	2%	30%	6%	55%	45%			45%	100%
Paraguay	27%	0%	38%	10%	76%	23%	1%	0%	24%	100%
Uruguay	25%	11%	29%	19%	84%	14%	2%	0%	16%	100%
LAC average	45%	5%	26%	3%	79%	18%	2%	0%	20%	100%

Note: The LAC averages of shared means of transportation and non-shared transportation do not include Honduras.

Figure A3: Household transportation expenses by country

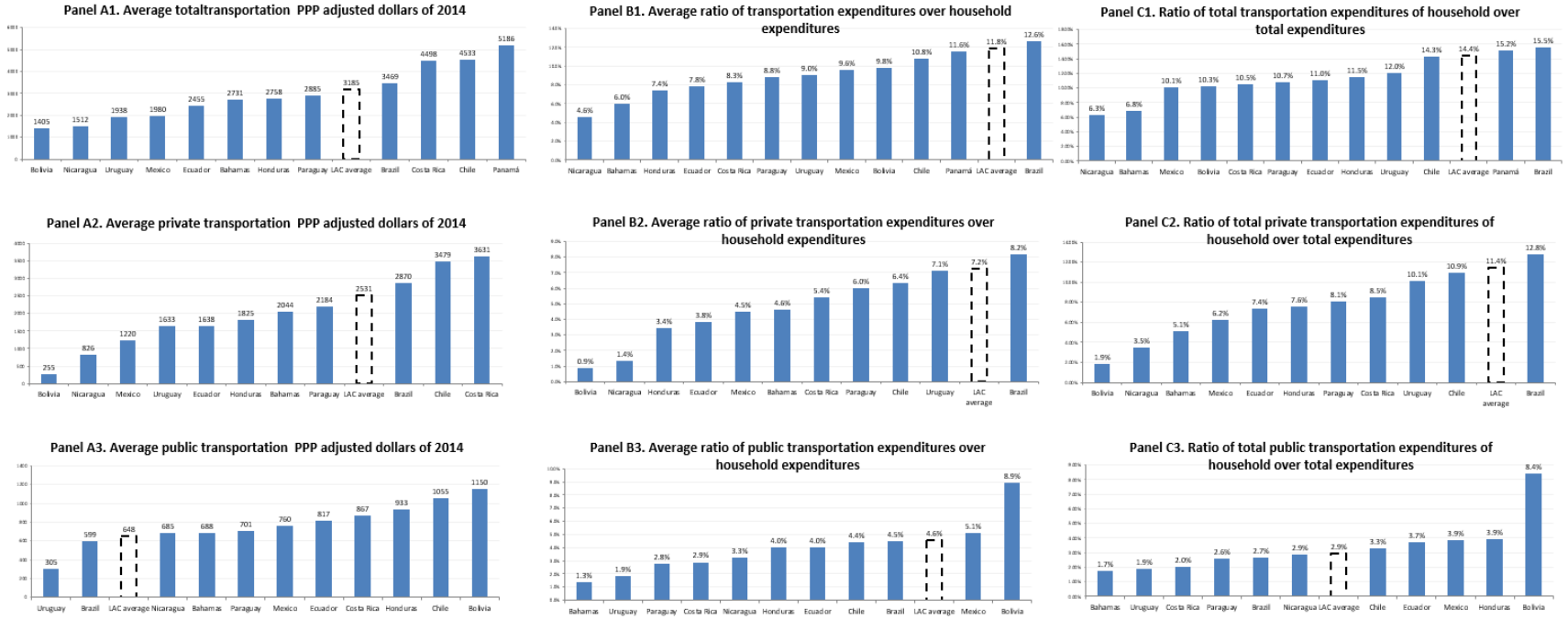


Table A4. Transportation expenses stats and inequality measures

Household transportation expenditure in PPP adjusted annual dollars				Household transportation expenditure as a % of total household expenditure			GINI indexes			
Country	mean	median	percentile 90	mean	median	percentile 90	GINI index of household expenditure in transportation	GINI index of total household expenditure	GINI index of income from World Development Indicators	GINI index of income from our estimates
Bahamas	2876	1510	5415	6.0%	4.6%	10.8%	0.555	0.377	-	0.422
Bolivia	1371	778	3052	9.7%	8.4%	19.8%	0.553	0.434	0.550	0.570
Brazil	3298	1003	7655	12.1%	7.8%	31.5%	0.671	0.532	0.541	0.565
Chile	4175	1425	10348	10.2%	7.1%	24.2%	0.671	0.456	0.505	0.492
Costa Rica	4201	1227	9797	7.9%	4.9%	19.6%	0.689	0.497	0.492	0.502
Ecuador	2375	784	4281	7.6%	5.0%	15.3%	0.706	0.382	0.464	0.439
Honduras	2695	701	5767	7.3%	4.2%	17.8%	0.721	0.428	0.584	0.541
Mexico	1890	1114	3835	9.3%	7.8%	18.7%	0.544	0.426	0.481	0.443
Nicaragua	1470	481	3208	4.5%	3.2%	10.3%	0.678	0.456	0.457	0.479
Panama	4924	2004	10925	11.1%	8.7%	23.3%	0.652	0.420	0.528	0.443
Paraguay	2789	1424	6628	8.6%	7.0%	18.6%	0.581	0.356	0.526	0.474
Uruguay	1669	519	4016	7.9%	4.2%	19.4%	0.635	0.381	0.465	0.374
LAC average	3185	1114	7120	11.8%	8.0%	29.3%	0.668	0.510	0.501	0.598

Note: The WDI Gini is for the same year as our microdata. They are the following: Bolivia (2004), Brazil (average 2008-2009), Chile (2013), Costa Rica (2013), Ecuador (average 2011-2012), Honduras (2004), Mexico (2012), Nicaragua (2009), Panama (average 2007-2008), Paraguay (2011), and Uruguay (average 2005-2006).

Figure A5: Mexico's transportation spending over time by income quintile

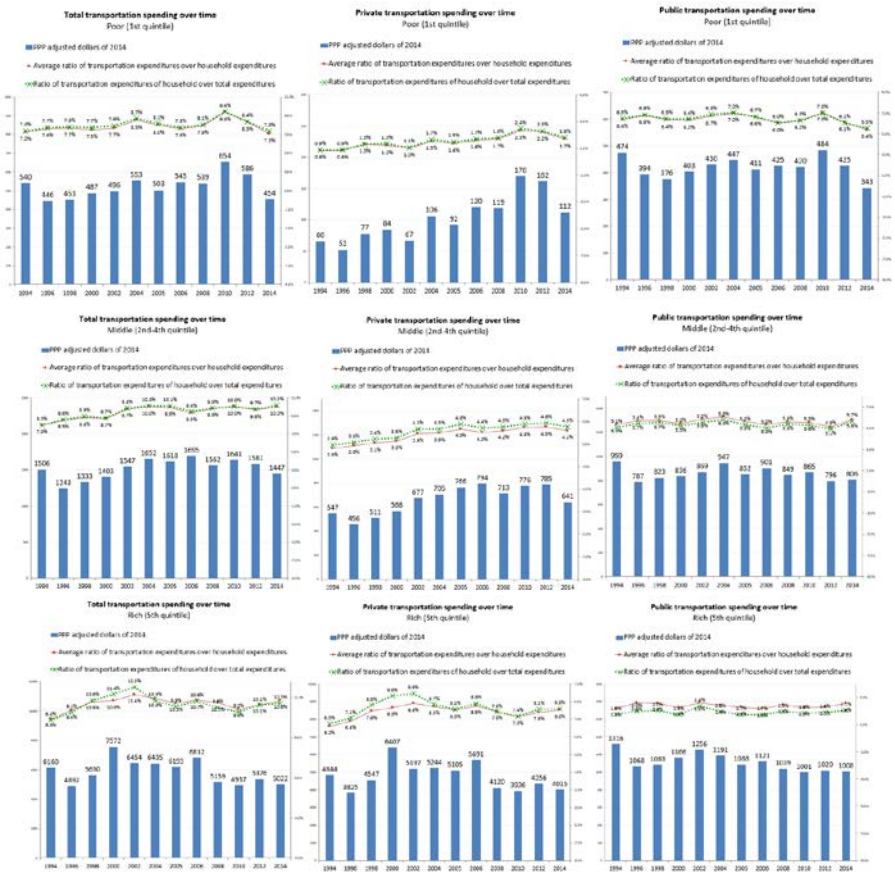
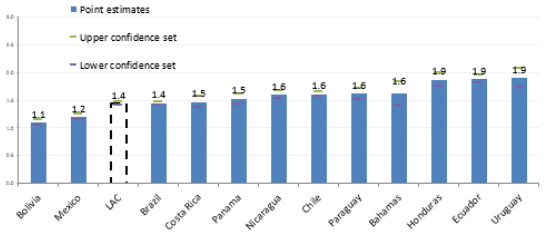
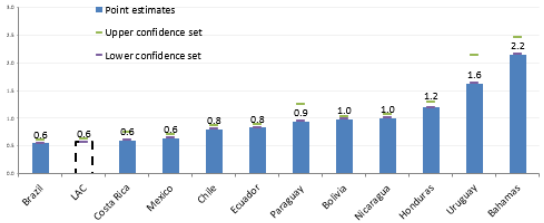


Figure A6: Expenditure elasticities by country

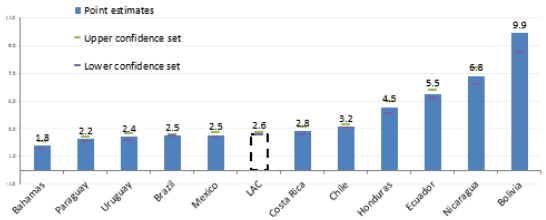
Panel A. Total transportation spending.



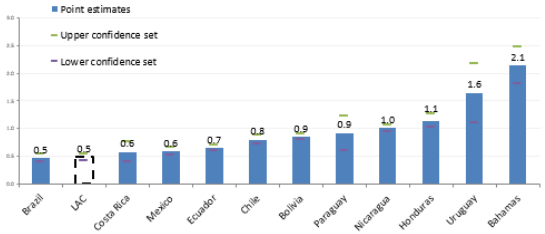
Panel B. Spending in public means of transportation.



Panel C. Spending in private means of transportation.



Panel D. Spending in bus.



Panel E. Spending in fuel.