www.cepal.org/transporte

Issue No. 367 – Number 7/2018
Original: Spanish

BULLETIN FAL

FACILITATION OF TRANSPORT AND TRADE IN LATIN AMERICA AND THE CARIBBEAN

Road transport in Latin America: evolution of its infrastructure and impact between 2007 and 2015

This issue analyses data on investments in Latin American road infrastructure between 2007 and 2015, examines the subsector's evolution and emphasizes the negative repercussions of accident fatalities and carbon emissions. It aims to raise awareness about the importance of this mode of transport in the region and to underscore the need for socioeconomic evaluations of road projects and for additional, better and more transparent data and information on the sector, using a cross-cutting approach in pursuit of sustainable development.
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Background

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Background

Investing in road transport infrastructure is essential to the development of both the sector and the economy as a whole: it connects people and provides them with access to different public services and markets, including those for goods, services and jobs. Offering more and better road connections allows more affordable and more fluid transportation of people and goods, because it promises improvements in the effectiveness and security of operations for an optimal expansion of infrastructure in accordance with needs, which leads to lower costs and increased efficiency in personal mobility and cargo logistics. All this should have a positive influence on the dynamics of the markets served by logistics chains that largely depend on ground transport.

In this way, the benefits of more and better road infrastructure are reflected in the competitiveness, efficiency and aggregate costs of the economy, provided that the negative externalities of the deployment and use of infrastructure —such as air, water and ground pollution, accidents, greenhouse gas emissions, congestion and noise pollution— are avoided or minimized. Those external costs affect people's living conditions and so have consequences for society as a whole. In addition, if those external costs are not taken on board —in other words, if they are not covered by the fees paid by users or by the private costs of the supplier company— the private cost will be lower than the social cost (or the social benefit will be lower than the private benefit), which will encourage the non-efficient use of resources and favour projects to the detriment of others with a lower social cost. In such a situation, infrastructure and its benefits are not sustainable.

ECLAC, as an organization of the United Nations, is working to fulfil the 2030 Agenda for Sustainable Development; thus, in keeping with Sustainable

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ISU INFRASTRUCTURE SERVICES UNIT
Natural Resources and Infrastructure Division, UNECLAC

ISSN 1564-4243

Development Goal 9, it seeks to promote the building of resilient infrastructure[1] and inclusive and sustainable industrialization and innovation. Transport is a component of economic infrastructure and, within it, the roads subsector plays a crucial role in moving people and goods in Latin America.[2]

This FAL Bulletin aims to guide the countries' agendas towards efficient, inclusive, clean, resilient and safe infrastructure: all necessary qualities that are a part of the principles that underpin comprehensive and sustainable logistics and transport policies.[3] It offers an overview of the recent evolution of the physical infrastructure of the road transport sector in Latin America ("the region"), taking into account the public and private investment channelled into the sector (section II). It then compares its negative environmental and social impact with economic performance, examining, first, greenhouse-gas emissions and the number of traffic accident fatalities and, second, gross domestic product. In other words, indicators of intensity and elasticities are used to determine whether economic performance and investments in the sector were coupled to those negative impacts or not (section III). Finally, section IV offers a summary of those descriptions and analyses and proposes recommendations for enhancing the sustainability of the region's road infrastructure.

I. Investment, stock and quality in the Latin American roads subsector

Investment in infrastructure and the provision of infrastructure services in the region's countries is inadequate, inefficient and unsustainable. That is the first assessment set out the introduction to the paper by Sánchez and others (2017), which shows that the simple average investment in infrastructure as a proportion of GDP, for a group of six selected countries, stood at 2.2% between 2000 and 2015, with public and private investment almost balanced (51% and 49%, respectively), at a time when, according to the growth forecasts for the region's economy, the estimated levels of infrastructure investment required (including maintenance and repairs) should have ranged between 5.1% and 7.4%.[4] According to the data cited in that document, the investment allocated to the transport sector —specifically, roads and railways— amounted to 39.1% of the overall total for the 2000–2015 period. In terms of the six countries' GDP, that was the equivalent of a simple average annual investment in this transport subsector of 0.8% between 2000 and 2015, with public funds far outstripping private investment (70% and 30%, respectively).[5]

To focus on road transport, the following section analyses the evolution of investment in that subsector between 2008 and 2015 in 14 of the region's countries. Together, this group of countries accounts for 78.5% of the region's GDP and 80.1% of its population (according to ECLAC data for 2008–2015). Taking this as representative sample, and using data from Infralatam (http://www.infralatam.info/) for the period in question, it can be concluded that the region's average annual investment in the roads subsector was 0.7%, with similar levels of public and private participation as indicated above for roads and railways taken together in the six countries (72% and 28%, respectively). First, this regional percentage does not reflect the wide variation between the countries' willingness to invest in relation to their GDP, as can be seen on figure 1. Second, compared with benchmark countries from other regions, it can be concluded that the region's effort is not far below —or even surpasses— that made by such developed economies as Germany, the United States and the European Union (27 countries), but is below the figures for China, the Republic of Korea and Japan. The explanation for this, however, could be related to the stock and quality of road infrastructure already attained by those developed economies and to the pursuit of infrastructure development policies, either recently (as in the case of China) or, alternatively, that began long ago as part of comprehensive, long-term approaches (such as the experiences of Germany and the Republic of Korea, analysed by Cipoletta, Pérez and Sánchez, 2010).

1 Several definitions of resilience exist, including "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management" (UNISDR, 2017).

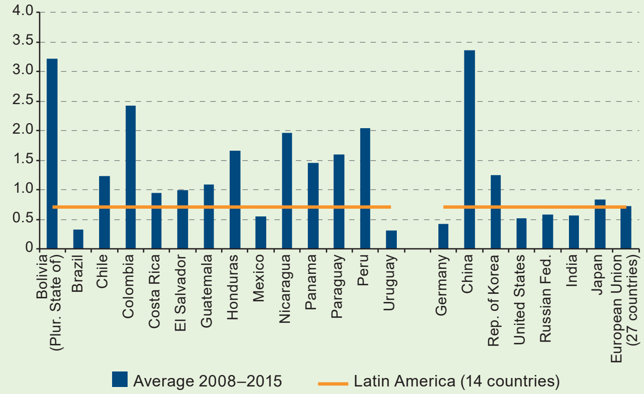
2 According to figures from some of the region's countries, it can be estimated that road cargo haulage accounts for more than 80% of the total volume of goods carried. At the national level, roads also account for a majority of people's journeys. In Chile, for example, roads carry 92.7% of the country's total goods tonnage (Association of Engineers of Chile, 2016) and for 60.9% of intercity passengers (CONICYT (2010); in Uruguay, they account for 99% of public passenger transport and 97% of domestic haulage (Cáceres and Farinasso, 2013).

3 The paper by Jaimurzina, Pérez and Sánchez (2015) sets out and explores the vision proposed for logistics and mobility policies (goods haulage and passenger transport) by the ECLAC Natural Resources and Infrastructure Division. Specific issues related to energy efficiency in road haulage and at ports, security of road haulage operations, road safety and other topics have been dealt with in earlier FAL Bulletins (past issues of which are available at https://repositorio.cepal.org/handle/11362/60).

4 The selected group of countries comprises Argentina, Brazil, Chile, Colombia, Mexico and Peru. Data and information from those countries were used to estimate the infrastructure investment needed in Latin America to respond, over the 2016–2030 period, to "demand" caused by growth in the economy and in the economically active population and to an unmet "need" for living standards (such as universal access to basic services, including electricity, fixed broadband, and water and sanitation). For regional GDP growth forecasts of 2.5%, 3.2% and 3.9% a year, the estimated infrastructure investment needs (including maintenance and repairs) would be 5.1%, 6.2% and 7.4%. For further details on the results and an explanation of the methods used, see Sánchez and others (2017).

5 All the percentages for shares of investment (for the public and private sectors and for the road and rail subsectors) cited thus far are calculated in current dollars in accordance with records for the six selected countries.

Figure 1
Latin America (14 countries) and world countries and regions (selected economies): average investment in the roads subsector as a proportion of GDP, 2008–2015
(Percentages of GDP)



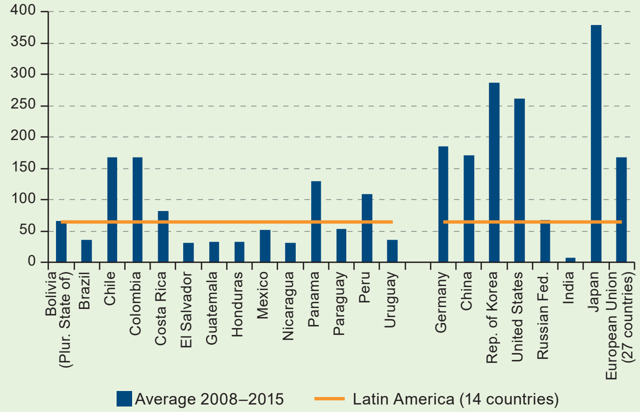
Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of data from Infralatam [online database] http://www.infralatam.info/ [accessed on: 20 September 2018]; and International Transport Forum (ITF), "Transport infrastructure investment and maintenance", ITF Transport Statistics [online database] https://doi.org/10.1787/g2g55573-en [accessed on: 17 September 2018].

Note: Figures for the Republic of Korea and Japan do not include private investment, and those for India do not include investments by public-private partnerships; data for Germany do not include maintenance expenses; European Union (27 countries) does not include Cyprus.

Dividing annual road investments by the countries' total populations yields an average, for Latin America (14 countries), of US$ 64 per capita (at 2010 constant prices) between 2008 and 2015. Wide variations within the region can again be seen in this indicator, and those countries that tended to invest the most in terms of GDP and population were Chile, Colombia, Costa Rica, Panama, Peru and the Plurinational State of Bolivia. Comparing the region to the selected benchmark countries, the difference between the region's average per capita investments and those of the developed economies, the European Union and even China is more pronounced, with average per capita investment amounts among the latter group of more than US$ 150 dollars over 2008 to 2015 (see figure 2).

As shown on figure 3, the investment trend in Latin America (14 countries) over the 2008–2015 period was slightly upwards, with two years (2009 and 2014) notably above the averages (0.7% of GDP and US$ 64 per capita). The region reported its minimum GDP in 2009 and its maximum in 2014; thus, regardless of the heterogeneity that might be hiding behind the averages and the need for a closer study of the topic, the countries in general applied a countercyclical policy for road infrastructure spending in 2009 and a procyclical policy in 2014. Of the group of 14 countries, those reporting a clearly rising trend in road investment between 2008 and 2015 were Colombia, Nicaragua, Panama, Paraguay, Peru, the Plurinational State of Bolivia and Uruguay. Then, comparing the regional trend with that of the selected benchmark countries reveals that only China and India reported an upward trend in road investment over the period in question (in the remaining economies, in contrast, the trend was pronouncedly downwards).

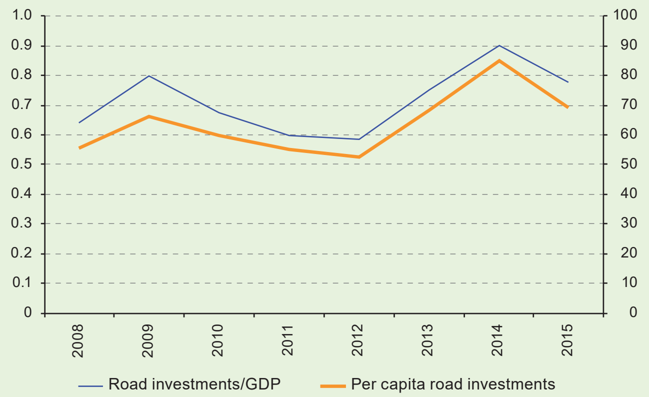
Figure 2
Latin America (14 countries) and world countries and regions (selected economies): average investment in the roads subsector by population, 2008–2015
(Dollars at 2010 constant prices)



Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of data from Infralatam [online database] http://www.infralatam.info/ [accessed on: 13 September 2018]; World Bank, World Bank Open Data [online database] https://data.worldbank.org/ [accessed on: 20 September 2018]; and International Transport Forum (ITF), "Transport infrastructure investment and maintenance", ITF Transport Statistics [online database] https://doi.org/10.1787/g2g55573-en [accessed on: 17 September 2018].

Note: Figures for the Republic of Korea and Japan do not include private investment, and those for India do not include investments by public-private partnerships; data for Germany do not include maintenance expenses.

Figure 3
Latin America (14 countries): investment in the roads subsector in terms of GDP and population, 2008–2015
(Percentages of GDP (left axis) and dollars at 2010 constant prices (right axis))

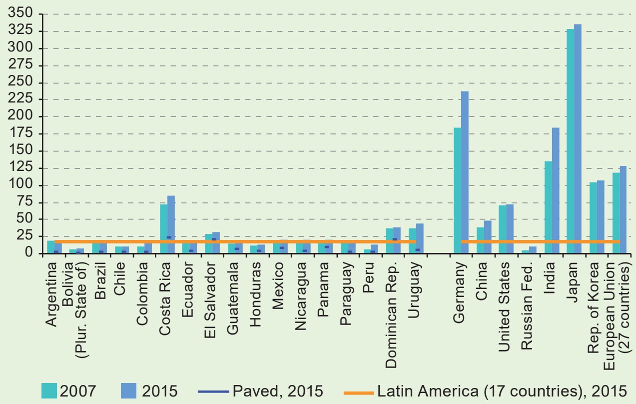


Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of data from Infralatam [online database] http://www.infralatam.info/ [accessed on: 13 September 2018]; and World Bank, World Bank Open Data [online database] https://data.worldbank.org/ [accessed on: 20 September 2018].

Infrastructure investments in the roads subsector can be measured, albeit with some limitations, by the road stock. In Latin America (17 countries), the ratio of total road length to land area[6] increased by slightly over 8% between 2007 and 2015 —that is, by 1% annually— to reach 18 km of roads for each 100 km2 of territory. With the exception of Brazil, as can be seen on figure 4, all the countries increased their road densities between 2007 and 2015 and, in ten of them, the increases were greater than the regional average. Particularly notable were the improvements in Peru and Colombia, followed by those of Uruguay, the Plurinational State of Bolivia, Costa Rica, Nicaragua and Panama. As noted above, this reflects subsector investment trends in the countries in question (that is, rising rates of investment, on average above the regional figure; with the exception of Uruguay, where the rate has been rising, but on average more slowly than in the region as a whole). The countries with the highest road densities by land area in 2015 were Costa Rica, Uruguay, the Dominican Republic and El Salvador. These were followed, with results slightly above the average for the selected 17 Latin American countries, by Panama, Nicaragua, Mexico, Argentina, Brazil and Colombia. Nevertheless, those relative stock figures fail to take account of the quality of the infrastructure: the majority of the region's highways are not main roads, they use different designs and technologies and, because many are not surfaced, they are not fit for purpose (or for the weights they carry, in terms of either cargo or passengers). In Latin America (17 countries), in 2015 slightly below 18% of the total road network was surfaced, for a total of 3 km of roads per 100 km^2 of territory. Variations within the region can be seen in this indicator: nine of the countries report figures above the average percentage, notably El Salvador, the Dominican Republic, Guatemala, Panama and Mexico, where the proportion of paved roads represents more than 40% of the total. Comparing the density of paved roads to land area, a particularly good result was also reported by Costa Rica (alongside the Dominican Republic and El Salvador), with more than 20 km per 100 km2. The levels of quality in the countries' road stock can also be assessed through the evolution of investment in the subsector and, as will be seen below, through analyses of opinion surveys on road quality. Thus, as can be seen below on figure 5, with the exception of Costa Rica, these five countries reported quality assessments for 2015–2016 that were above the regional average (albeit with a pronounced downward trend in El Salvador and Guatemala).

At the same time, all the selected benchmark countries —developed and developing alike— reported increases in their total road networks between 2007 and 2015. Particularly noteworthy were the relative changes in the Russian Federation, India, Germany and China. The rate of change within the European Union (27 countries) was similar to that of Latin America (17 countries), while that of the remaining developed countries was below the Latin American average. In addition, with the exception of the Russian Federation, those economies greatly outstrip the region in terms of total road network density (expressed in relation to land area).

Figure 4
Latin America (17 countries) and world countries and regions (selected economies): road network density, total and paved, in relation to land area, 2007 and 2015
(Kilometres per 100 km^2 of land area)



Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of data from World Bank, World Bank Open Data [online database] https://data.worldbank.org/ [accessed on: 20 September 2018]; Organization for Economic Cooperation and Development (OECD), OECD.Stat [online database] https://stats.oecd.org/; and Economic Commission for Europe (UNECE).
Note: Figures for Ecuador are from 2008 and 2014; data for Germany are from 2007 and 2012.

As already stated, the quality of road transport infrastructure can also be assessed through perception surveys, such as those sent out by the World Economic Forum (WEF) to company executives for calculating the Global Competitiveness Index (GCI). The GCI is based on three subindices that involve 12 pillars covering 114 indicators.[7] The basic requirements subindex contains the infrastructure pillar and several

[6] Land area and not total surface area is used for the indicator. Hence, areas covered by bodies of water —both inland and offshore, such as rivers and coastlines— are excluded from the calculation.

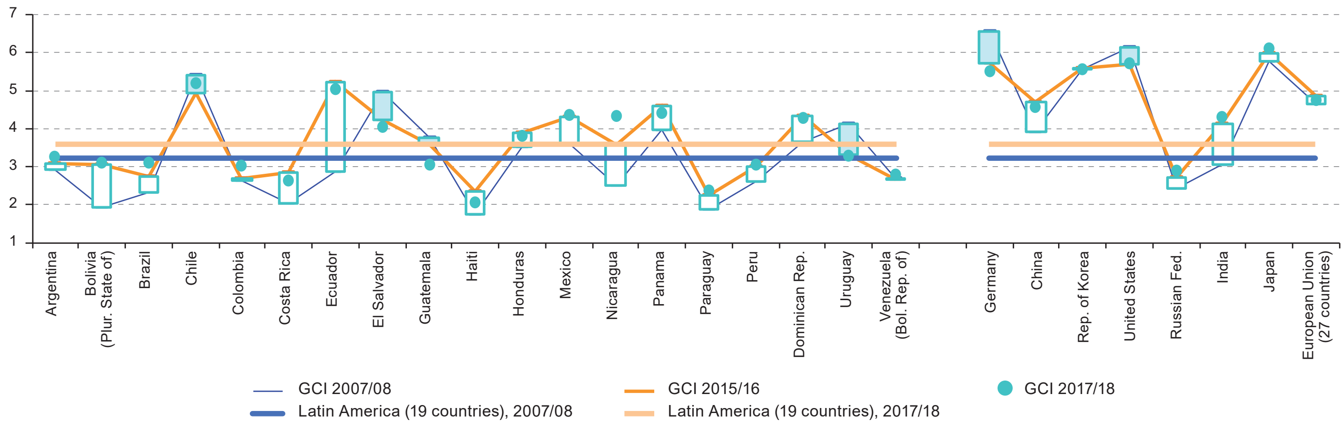
[7] For additional details and explanations about the methods used to construct the GCI, see WEF (2017).

related indicators, one of which is road quality. Specifically, the indicator is based on the following question: "In your country, how is the quality (extensiveness and condition) of road infrastructure?" Replies cover a range of seven answers, from 1 (extremely poor; among the worst in the world) to 7 (extremely good; among the best in the world).

As can be seen on figure 5 below, the score for Latin America (19 countries) in the most recent 2017/2018 survey was 3.6, which represents a slight improvement over the results in 2007/2008 (3.2) and 2015/2016 (3.5). Although this indicator is a regional average, which conceals the variations that exist among the region's countries, with some scoring much higher than others, the gap between the countries fell slightly during the period under study (measured both by range and by the ratio of change). This was the result of improved appraisals of road quality in 15 of the 19 countries (in contrast, the score fell for Chile —which nevertheless remains the region's leader— and for El Salvador, Guatemala and Uruguay). At the same time, eight countries reported scores above the regional average, a result that has not changed since the 2007/2008 survey. Comparing the region to the selected benchmark economies, the improvement in Latin America (19 countries) is dwarfed by the progress made in India, China and the Russian Federation, as well as by that of Japan and the European Union (27 countries). In addition, the region remains below those economies and betters only the Russian Federation (when in the 2007/2008 survey it also was ahead of India).[8]

In the region's countries, the number of vehicles—which traverse those countries' roads and, in some cases, those of their neighbours, making use of their capacity and generating direct and indirect effects, both positive and negative— is a catalyst for demand for the subsector's infrastructure. In Latin America (17 countries), the total vehicle fleet by population rose by more than 59% between 2007 and 2015 —that is, by around 6% a year— to reach a total of 322 vehicles per 1,000 inhabitants. As shown on figure 6, all the countries increased their fleets during this period. Particularly notable were Paraguay, which more than doubled its vehicles-to-population ratio, and Colombia and the Plurinational State of Bolivia, which were very close to matching Paraguay's performance. Another seven countries —Ecuador, Uruguay, Brazil, Honduras, Argentina, Guatemala and Panama— reported results higher than the regional percentage change. El Salvador was the country with the slowest fleet growth (close to 3% a year), but that figure was still higher than the rate of expansion in subsector investments and in the physical road stock. That situation was repeated in almost all the region's countries: greater relative growth in their vehicle fleets compared to the expansion in infrastructure investments and in the road stock.[9] As an additional data point, passenger cars, sports cars and SUVs (including taxis) for passenger transport make up approximately 56% of the region's fleet (this percentage is an estimate since vehicle classification methods vary from one country to the next or, in some countries, breakdowns do not exist at all).

Figure 5
Latin America (19 countries) and world countries and regions (selected economies): road quality indicator
(Decimal numbers from 1 to 7)



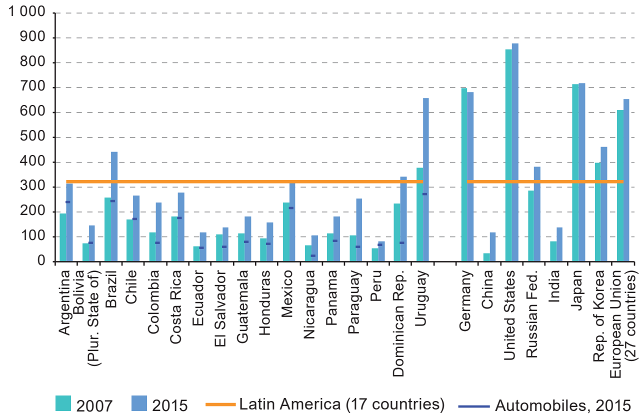
Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of World Economic Forum (WEF), "The Global Competitiveness Index dataset 2007–2017", Geneva, 2017 [online] http://www3.weforum.org/docs/GCR2017-2018/GCI_Dataset_2007-2017.xlsx.
Note: The road quality index for each country is calculated from the average ratings reported; for further details on those calculations, see WEF (2017).

[8] As an additional data point, the three countries of the world with the best score on the road quality indicator in the 2017/2018 survey (WEF, 2017) were the United Arab Emirates (6.37), Singapore (6.35) and Switzerland (6.35). Those with the worst results were Mauritania (2.01), the Democratic Republic of the Congo (2.05) and Haiti (2.06).

[9] The exception was Peru, where the relative growth rate in the vehicle fleet was lower than the rate of growth in the total road stock but higher than that of subsector infrastructure investments. Nevertheless, road stock quality —expressed as the proportion of paved roads— is low.

Comparing with the selected benchmark countries, vehicle fleet growth in China and India was higher than that of Latin America (17 countries); China's expansion, in particular, was explosive, with the number of vehicles per 1,000 inhabitants tripling between 2007 and 2015. In the Russian Federation, the growth of the fleet-to-population was not marginal; in contrast, for the developed countries and the European Union (27 countries), the growth rate in this indicator was lower than that of the Latin American country with the least change (El Salvador). In Germany, the indicator even fell slightly over the study period. Again it can be seen that the developed countries, and also China, report more similar figures for growth in investment and road stock and for the expansion of their vehicle fleets.

Figure 6
Latin America (17 countries) and world countries and regions (selected economies): automobile fleets by population, 2007 and 2015
(Number of vehicles per 1,000 inhabitants)



Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of data from World Bank, World Bank Open Data [online database] https://data.worldbank.org/ [accessed on: 20 September 2018]; Organization for Economic Cooperation and Development (OECD), OECD.Stat [online database] https://stats.oecd.org/; and Economic Commission for Europe (UNECE).

Note: "Automobiles" covers four-wheeled passenger cars, SUVs and sports cars intended for the conveyance of passengers, including taxis (collective vehicles, such as buses, and lorries, pick-up trucks and others, such as tractors, are not included); disaggregations performed according to information from national sources, when possible; the number of automobiles in Uruguay includes trucks, buses and ambulances; figures for India are for 2007 and 2013.

II. Damaging effects of road infrastructure and its use in Latin America

Along with the positive effects of road infrastructure on the economy, its agents and society as a whole, it also has negative repercussions. These are more cross-cutting in nature and persist over time: in other words, they have an intergenerational impact. The most notable and worrying examples are the deaths and injuries caused by accidents, and the pollution created by both vehicles and the infrastructure itself. In the region, taken as meaning the 20 countries of Latin America, the negative externalities in 2015 —measured not in monetary terms, but in the number of traffic accident fatalities and the volume of carbon dioxide (CO_2) emissions— were estimated at 93,500 people and 548.6 million tons, respectively. The death figure is equal to 15.4 people per 100,000 inhabitants in the region, and the emissions represent 34.3% of the total CO_2 emissions generated by total fuel consumption, making road transport the sector that contributes the largest share of emissions.[10] It should also be noted that traffic accidents were the ninth most common cause of death in the region in 2015 (the same position as in 2007).[11]

There are other forms of negative externalities that must be measured and assessed, in monetary terms as far as is possible. For instance, the private transport costs paid by households and companies do not correspond to the social costs borne by society, which leads to the inefficient use of the economy's resources. Thus, for example, if using a mode of transport creates costs that are not charged for, demand for that mode of transport could be encouraged while at the same time undermining another form of transport with lower costs to the community. Moreover, it generally holds true that transport is the sector that receives the largest share of public infrastructure investment. According to Infralatam data for Latin America (14 countries), between 2008 and 2015 this sector accounted for 47.7% of public infrastructure investment (followed by energy with 35.1%, water with 14.9% and telecommunications with 2.6%).[12] Within that total, the road transport subsector accounted for the largest portion, receiving 78.2% of all public investment in the sector (followed by the river and maritime-port subsectors with 8.6%, railways with 7.8% and air transport with 5.3%).

Thus, given the significant impact of the roads subsector and its substantial participation in the policies and budgets of the region's governments, the search for a better rationale for public spending —and the imposition of levies on taxpayers and/or the charging of user fees, particularly at times of account deficits and economic and financial instability— requires the use of socioeconomic evaluation or calculation tools that take due account of externalities in choosing between infrastructure projects, in decision-making regarding rules and regulations and in the decisions of private economic agents, such as individuals, households and companies.

[10] The figure for traffic accident fatalities was estimated by the ECLAC Natural Resources and Infrastructure Division using national sources from 19 of the 20 countries (Haiti was excluded because information was not available) and so the calculation method may vary from one country to the next. The figure for road transport fuel CO_2 emissions was calculated for the 20 countries on the basis of IEA (2018).

[11] This estimate was calculated for the 20 countries from the data catalogue of the Global Health Data Exchange (GHDx) of the Institute for Health Metrics and Evaluation (IHME) (see [online] http://ghdx.healthdata.org/). In 2017, this cause of death was the tenth most common in the 20 countries; traffic accidents rank outside the top ten causes of death in only four countries, and in two of them it is in the top five.

[12] For the same sample of countries and year range, 57.5% of the region's total investment in infrastructure came from public funds and 42.5% was private. The sector breakdown of private infrastructure investment was as follows: energy, 47.9%; transport, 36.3%; telecommunications, 11%; and water, 4.8%.

The Government of France provides an example of efforts to measure transport both from the sectoral point of view, with annual transport statistics (e.g. *Les comptes des transports*)[13] and in monetary terms (in other words, its socioeconomic impact). The Boiteux II Report covers the latter aspect, and it also includes the methodologies used to estimate the monetary cost of externalities.[14] More recently, the paper by Auverlot and others (2016), which summarizes a series of discussions on the socioeconomic evaluation of public investment projects, offers an overview of methods and progress with the topic of appraising different aspects of externalities: value of human life, biodiversity, carbon (on account of greenhouse gases), agglomeration effects and natural disasters (on account of climate change).

Road transport externalities can be classified into three groups according to the dimensions of sustainability: economic (such as benefits related to accessibility, benefits related to economies of agglomeration, costs related to the depreciation of infrastructure through use, costs related to congestion and costs related to accidents); environmental (such as costs related to greenhouse gases, costs related to air pollution, costs related to noise and visual pollution, costs related to the occupation of spaces and soil artificialization and costs related to the destruction of ecosystems and damage to biodiversity); and social (such as benefits related to accessibility, benefits related to collective and human-powered modes of transport, costs related to low levels of safety, costs related to morbidity and mortality and costs related to the occupation of urban spaces) (CGDD, 2013).

Data and information are needed for socioeconomic evaluations and for the creation of indicators to measure the performance of infrastructure and its related services; however, in the region's countries, there is a dearth of such resources. In the roads subsector, for example, only some countries have up-to-date statistics on their road stock by surface type, or on their vehicles by type and age. Neither do they have data series covering operations, such as cargo or passenger movements. The absence of data, information and, consequently, indicators is not limited to the roads subsector; it also affects the other transport subsectors. This hinders any attempt to analyse and assess the sector's situation and evolution.

Given that limitation, and in light of the importance of roads over other modes of transport and the role that they play in different processes —not only logistical, productive and commercial, but also cultural, political, social and other ways in which people interact— an analysis of the subsector illustrating the harmful effect that development processes can entail as a result of the relationship between economic growth, transportation and its externalities is proposed. Transport activities tend to increase as a result of economic growth, and that relationship feeds back into itself, depending on its behaviour and the incentives created, and on the performance and location of economic activity, through productivity, investment and employment (Venables, Laird and Overman, 2014). This can lead to an expansion in the vehicle fleet, vehicle flows and distances travelled, but also to a rise in traffic accidents. In turn, this is related to increases in energy consumption, CO_2 emissions and other negative externalities that can lead to environment deterioration and a lower quality of life (Loo and Banister, 2016).

This discussion therefore accepts that economic growth is desirable (and necessary for developing countries), but not at the cost of the environment and the quality of life. This leads to the concept of decoupling and, in the context of this document, of decoupling the negative externalities of road transport from economic growth. The proposal for this analysis, therefore, involves repeating a part of the exercise set out in the paper by Loo and Banister (2016).[15] This work expands the theoretical debate and the methodology for decoupling transport to cover the three dimensions of sustainability. To that end, the authors focused on a group of 15 countries over a period of 22 years to examine the evolution of the relationship between economic expansion (growth in incomes and in transport activities) and transport's environmental and social externalities (CO_2 emissions and fatalities). These two negative externalities of transport were chosen because they "represent examples of environmental and social costs associated with rising levels of mobility". The work seeks to identify situations where good practices were employed to reach the goal of sustainable economic growth with a minimal negative impact on the environment and society.

In keeping with Loo and Banister (2016), to measure the decoupling of the negative externalities of transport from economic growth, two indicators are used that, taken together, allow the construction of a general frame of reference. The first indicator is the elasticity of the negative externality i of transport with respect to income:[16]

[13] See [online] http://www.statistiques.developpement-durable.gouv.fr/donnees-densemble/1924/874/ensemble-comptes-transports.html.

[14] The Boiteux II Report is the name given to the General Planning Commission's document *Transports: choix des investissements et coût des nuisances* (CGP, 2001).

[15] Loo and Banister (2016) explain that the concept of decoupling transport from economic growth has become popular, as growth in the economy is seen as desirable but it should not be contingent on similar growth in the use of carbon-based transport. They add that decoupling entails both immaterialization (decoupling production and material consumption from economic production; e.g. indicators of energy intensity or transport intensity) and dematerialization (decoupling environmental damage from production or material consumption; e.g. indicators of carbon intensity in energy or of carbon intensity in transport). Decarbonization, measured as carbon intensity within the economy, is an example of dematerialization.

[16] In their paper the authors do not specify how they calculated elasticity, for which reason this document uses the midpoint method.

$$E_i = \frac{\Delta x_i}{\Delta Y}\frac{\overline{Y}}{\overline{x_i}} \qquad (1)$$

Where Δxi is the quantity change in the negative externality i of transport, $\overline{x_i}$ is the average quantity of the negative externality i of transport, Δy is the change in income or GDP and $\overline{Y}$ is average income or GDP. The second indicator is the intensity of the negative externality i of transport with respect to income:

$$I_i = \frac{x_i}{Y} \qquad (2)$$

Where x_i is the amount of the negative externality i of transport and Y is income or GDP.

In the case at hand, i can be either tons of CO_2 equivalent generated by the roads subsector through the burning of fuel in all its activities or the number of traffic accident fatalities. Income or GDP has been calculated as dollars at constant 2010 values.

The indicators for intensity (I_i) and elasticity (E_i) define four decoupling and coupling relationships (out of a possible total of eight) between income and negative externalities at the national or regional level:

- Relative decoupling: when income (Y) and the negative externality i (x_i) change in the same direction, but intensity (I_i) decreases.
- Absolute decoupling: when income (Y) rises or holds steady and the negative externality i (x_i) decreases and, consequently, intensity (I_i) decreases.
- Relative coupling: when income (Y) and the negative externality i (x_i) change in the same direction but intensity (I_i) rises.
- Absolute coupling: when income (Y) decreases or holds steady and the negative externality i (x_i) rises and, consequently, intensity (I_i) rises.

Thus, the relationship can be one of decoupling if the intensity falls from one year to the next, or one of coupling in the opposite case. It can be absolute if the change in the two variables is in different directions, or relative in the opposite case. Then, elasticity (E_i) indicates the relative magnitude of the change in the variables: the change is strong if the absolute value of elasticity (E_i) is 1 or greater; and it is weak if the absolute value of elasticity (E_i) is below 1. The eight possible situations in the relationship between income growth and growth in the externality related to transport under study are presented on table 1 below.

Table 1
Frame of reference for changes in the relationship between income and the negative externalities of transport

	Decoupling (I_i decreases)		Coupling (I_i rises)	
	Strong	Weak	Strong	Weak
Absolute (Ei negative)	$\downarrow I_i$; $E_i \leq -1$	$\downarrow I_i$; $-1 < E_i < 0$	$\uparrow I_i$; $E_i \leq -1$	$\uparrow I_i$; $-1 < E_i < 0$
Relative (Ei positive)	$\downarrow I_i$; $E_i \geq 1$	$\downarrow I_i$; $0 < E_i < 1$	$\uparrow I_i$; $E_i \geq 1$	$\uparrow I_i$; $0 < E_i < 1$

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of B. Loo and D. Banister, "Decoupling transport from economic growth: extending the debate to include environmental and social externalities", *Journal of Transport Geography*, vol. 57, December 2016.

The green cells indicate the four possible decoupling relationships: the darkest green indicates the optimal situation —the most desirable from the perspective of sustainability— with strong absolute decoupling, where income growth is accompanied by a reduction in the negative externality associated with transport, and, in addition, in absolute values, the relative change in income is lower than the relative change in the externality. The red cells do the same for the possible coupling relationships: the darkest red indicates the worst situation, the least desirable for transport sustainability, in that it entails strong absolute coupling, where income falls at the same time that the negative externality of transport rises, and, in addition, in absolute values, the relative change in income is lower than the relative change in the externality.

If the indicators and this frame of reference are used to conduct the exercise for the region's countries —in this case, Latin America (19 countries)— with respect to traffic accident fatalities, a negative externality of road transport with immediate social and economic repercussions, the results reveal an improvement during the 2007 to 2015 study period. This was on account of a weak relative decoupling (lower intensity due to change in the same direction, but with the externality changing to a lesser extent) during the first two phases of the period, 2007–2010 and 2010–2013, followed by strong absolute decoupling in 2013-2015 (lower intensity due to changes in different directions, with the externality falling to a greater extent). Over the entire period, only two countries —Guatemala and Honduras— reported no decoupling of this road transport externality from the evolution of income. Again, there are pronounced variations in the typologies found in the region's countries; particular noteworthy were the results of Chile, Peru, Panama and Uruguay, which reported decoupling throughout the period and in each of its phases. Comparing the phases reveals that the 2010–2013 period was when the largest number of countries underwent decoupling (16 countries out of 19), followed by 2007–2010 (11 out of 19) and, finally, 2013–2015 (10 of 19). In the last phase, the number of countries experiencing decoupling fell with respect to the previous phase (from 16 to 10) but, as noted above, over the entire period there was an improvement and these variations in performance between phases were what caused most of the 19 Latin American countries to report weak relative decoupling. A comparison of the region's performance with that of the selected benchmark economies reveals that all of that group, developed and developing alike, experienced some degree of decoupling over the 2007–2015 period: strong absolute decoupling in six, weak absolute in one, and weak relative in another. The country reporting weak relative decoupling was India, similar to that of Latin America (19 countries). Note that only the United States reported a coupling phase (2013–2015).

A similar exercise can be conducted for the CO_2 emissions generated by the roads subsector's fuel consumption. In the region (Latin America, 20 countries), the typology detected over the 2007–2015 period for this externality, which has direct environmental and social repercussions, was one of strong relative coupling (greater intensity on account of change in the same direction, but to a larger extent for the externality). That typology appears in the first two phases (2007–2010 and 2010–2013); then, in the final phase (2013–2015), there was a slight improvement, with weak relative decoupling (lower intensity on account of change in the same direction, but to a lesser extent for the externality). Over the period, eight countries reported no decoupling of this externality of transport from income growth, and the typology was relative and strong. The variations among the countries' typologies are much more pronounced, with only two countries —the Dominican Republic and Uruguay— succeeding over the entire period and in each individual phase in decoupling road transport emissions from the evolution of income. A comparison of the phases reveals a similar trend for the road accident fatalities externality: the 2010–2013 phase has a higher number of countries experiencing decoupling (15 countries out of 20), followed by a smaller number of countries (7 out of 20) decoupling during the other two phases, 2007–2010 and 2013–2015. It should nevertheless be noted that, as indicated above, it is in this final phase that a very slight improvement is recorded for Latin America (20 countries). At the same time, in terms of the region's performance compared to the eight selected benchmark economies, six of them (including developing nation China) experienced some degree of decoupling between 2007 and 2015; in two of these, the decoupling was strong absolute; in one it was weak absolute; and in the other three it was weak relative. In contrast, the Russian Federation and India, both developing economies, reported strong relative coupling, as did Latin America (20 countries). The results obtained by Japan, the Republic of Korea and the European Union (28 countries) are particularly notable, in that throughout the period and in all its phases they reported some degree of decoupling.

The decoupling and coupling typologies identified for the region's countries and the selected benchmark economies can be found in annex table A1.1. Now that the efforts to reduce the negative externalities of transport with respect to income in each of the phases and the period as a whole have been identified, along with the outcomes of that process, an attempt can be made to correlate some of the trends with public policies in the sector: for example, as regards rules and regulations, investments in road infrastructure, road safety, fleet and vehicle turnover, etc. It would also be useful to take account of the intensities and elasticities in analysing the trends in the indicators and the behaviour of the variables. Annex tables A1.2 and A1.3 set out those indicators for the region's countries and the benchmark economies already identified in table A1.1.

For the Latin American region (19 countries), the intensity of road accident fatalities with respect to income fell, albeit gradually and slowly, for a total reduction of 13% over the 2007–2015 period. The period reported an almost marginal positive elasticity of 0.3, which confirms the earlier conclusion about the type of decoupling achieved (weak relative). As noted above, only two of the region's countries were unsuccessful in decoupling the accident fatalities externality (particularly the case of Guatemala, where the intensity rose by 39.2% between 2007 and 2015; this warrants special attention for a closer analysis of the problem and its possible solutions). Of the remaining countries that succeeded in their decoupling efforts, 12 reduced their levels of intensity by more than the regional average, particularly, in descending order of the relative change recorded, Peru, Panama, Uruguay, Chile and the Dominican Republic. Cross-referencing this information with the data for investments and road quality reveals that Chile, Panama and Peru are the countries with the highest per capita investments in the subsector and in addition, along with the Dominican Republic, they received quality appraisals above the regional average. The case of Uruguay, with relatively lower per capita investment and a poorer road quality appraisal than those countries, and with major growth in its vehicle fleet compared to the evolution of its road stock, could suggest that the country has good practices in the initiatives it has carried out in the area of road safety. Likewise, the countries' levels of intensity can also be compared. In spite of the progress made with the problem, which has a particularly strong impact on the social dimension, the cases of Honduras, Nicaragua, El Salvador, the Plurinational State of Bolivia and Paraguay are notable, with values well above the regional average of 1.6 deaths per 100 million dollars (at constant 2010 values) in 2015. Vehicle numbers in some of those countries expanded rapidly as a result of rising incomes and trade, but the capacity and safety of the road infrastructure remained comparatively unchanged. A comparison with the benchmark countries for the 2007–2015 period indicates that the reduction of intensity in all those economies, developed and developing alike, was also progressive but higher in relative terms than in Latin America (19 countries). In addition, with the exception of India, those countries report negative elasticities of less than -1. The intensity of the 19 Latin American countries in 2015 was higher than that of those economies, with only India reporting a higher figure (6.3).

In turn, the intensity of CO_2 emissions generated by the roads subsector with respect to income in the region (Latin America, 20 countries) remained practically stable, with a very slight increase of 1% over the 2007–2015 period. A non-marginal positive elasticity of 1.1 for the period confirms the remarks made about the strong relative coupling of this externality to income. As already noted, eight of the region's countries were unsuccessful in decoupling the subsector's CO_2 emissions externality; and, of the countries that were successful in reducing the intensity to a greater or lesser extent, two reported particularly notable relative changes: Cuba in first place, followed by the Dominican Republic. The evolution in the Dominican Republic could be analysed to detect good practices with road quality, the appraisal of which in the country has been rising to a level above the regional average. For Cuba, the relevant information is not available. Nevertheless, there are other factors that must be taken on board in an analysis of this kind: for example, attention could clearly be paid to the vehicles' characteristics, such as vehicle types, motor technologies, average fuel consumption, etc., and the share of the fleet in the transportation of goods and passengers. At the same time, a comparison can also be made of each country's level of intensity and how that affects the environmental dimension; notable within the region in that regard are the results of the Plurinational State of Bolivia, Paraguay and Honduras, which, in 2015, reported double the regional average of 95.4 tons of CO_2 equivalent for each million dollars (in constant 2010 values). Other countries at more than 50 percentage points above the average include Ecuador, Haiti, Nicaragua, El Salvador and Guatemala. Finally, a comparison of the region and the benchmark group reveals that between 2007 and 2015, the reduction in intensity was constant for four of the developed economies and, examining the three phases, it alternated in Germany and China. In contrast, two developing economies —the Russian Federation and India— saw increases in intensity, and in a larger proportion than Latin America (19 countries). In addition, the developing countries' elasticities are positive and close to or above 1, while those of the developed economies are lower than 1 or negative. The intensity of the 19 Latin American countries in 2015 was higher than that of those economies, with the sole exception of India (102.7).

III. Final comments

The region's investment in road infrastructure is inadequate in terms of both its coverage and sustainability. This point has been made in earlier ECLAC documents, some of which were identified in the introduction and section I. The data presented on investment and infrastructure quality in the subsector confirm that conclusion.

Nevertheless, as pointed out several times in this document, this is not a uniform region and there are many notable differences between the countries. Their different situations and the internal and external factors that shape them mean that their challenges, although often similar, arise with different levels of intensity and complexity. Thus, several of the countries are making major efforts as regards coverage, quality, safety and respect for the environment, but there are still some —occasionally, alarming— lags compared to the developed economies and some developing ones.

In order to improve the situation of the roads subsector in the region's countries as regards the three dimensions of sustainability and to attain a model of development that entails progressive structural change, this paper proposes improving policy design by taking on board the recommendations of Jaimurzina, Pérez and Sánchez (2015) regarding the comprehensiveness and sustainability of public logistics and transport policies, and by institutionalizing the use of performance indicators for different modes of transport, so that co-modality is the focus of infrastructure development and preference is given to those modes with the greatest social returns that comply with the guiding principles and common objectives. Only some countries carry out annual monitoring of their transport statistics, and those that do so focus on only a few variables, mostly sector-specific ones; they therefore lack a cross-cutting and complete perspective of the impact of infrastructure and its related services.

Reference was already made to France, which for some time has been working to establish and improve socioeconomic evaluations of works projects, such as those involving transport infrastructure. As already stated, the advantage of such evaluations is not only that they enable more effective and efficient resource allocation, in that they allow comparisons between projects and modes of transport with appraisals that include negative and positive externalities; they also indicate the intergenerational impact on the resources of the State, which is of particular relevance when government budgets are constrained, with major fiscal and financial burdens. As a tool, they reveal the costs of the negative effects on society, so that due account is taken of all aspects related to the management and allocation of responsibilities, risks and public and private resources for the well-being of all generations.

The paper by Auverlot and others (2016) summarizes the challenges still present in the socioeconomic evaluation of public investment projects in France. Some of them have also been identified by regional specialists in analysing experiences with concessions or public-private partnerships for infrastructure development. For example, Guasch (2004) highlights the need for a set of regulatory instruments, such as financial and cost models and benchmarking data for comparisons and analyses; Rozas, Bonifaz and Guerra-García (2012) emphasize the need to accept only projects that have been properly designed and the economic, social and environmental feasibility of which has been verified by public agencies; and Vassallo (2015) states that *ex ante* evaluations are not enough, because of contractual changes and renegotiations arising from incomplete contracts, and so *ex post* evaluations are also necessary; he also underscores the need for information transparency, since it is reasonable for society as a whole to be able to access information on public projects, such as contractual changes, financing conditions, service provision quality and other details.

The needs outlined below support this idea regarding the importance of socioeconomic evaluations with a view to the ultimate objective of sustainable development, primarily when the infrastructure sectors involved give rise to negative social and environmental externalities; they also justify the demand for increased and improved availability of data and information on those sectors in each of the region's countries.

The first is the need to better explain socioeconomic evaluations to policy-makers and to publicize them among the communities involved: it must be understood that socioeconomic evaluation aims to identify all the parties affected by a project and so is a matter of general interest. This then implies ensuring that socioeconomic evaluations are as readable, instructive and clear as possible. The presentation of evaluation results is therefore essential: consideration must be given to the use of indicators and to issues such as whether they are quantifiable or not and whether or not they can be expressed in monetary terms. Then, there is a need to further explore the cross-cutting topics related to socioeconomic calculation methods, such as the statistical value of human life, the value of biodiversity, the value of carbon, the effects of economies of agglomeration, the consideration of natural risks and natural disasters, *ex post* evaluations and the discount rate associated with the risks of a project. Finally, these discussions must be included within infrastructure governance so that ownership of this concern, of the topics giving rise to conflict and of their possible solutions is incorporated into sectoral policies.

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V. Annex A1

Table A1.1

Latin America (19 countries) and other economies: typologies of direction and effort in relations between the intensity and elasticity of (1) traffic accident fatalities with respect to income and (2) road transport CO_2 emissions with respect to income

Typology, with respect to:	(1) Accident fatalities				(2) Transport emissions			
	2007–2010	2010–2013	2013–2015	2007–2015	2007–2010	2010–2013	2013–2015	2007–2015
Argentina	WAD	WRD	SRC	WAD	WRD	WRD	SRC	WRD
Bolivia (Plurinational State of)	SRC	SRC	SAD	WRD	SRC	SRC	WRD	SRC
Brazil	SRC	WAD	SRD	WRD	SRC	SRC	SRD	SRC
Chile	WAD	WRD	WRD	WRD	SRC	SRC	WRD	SRC
Colombia	WAD	WRD	SRC	WRD	WAD	SRC	WRD	WRD
Costa Rica	SAD	WRD	SRC	WRD	WRD	WRD	SRC	WRD
Cuba	WRD	WAD	SRC	WRD	SAD	WAD	SRC	SAD
Ecuador	SRC	WAD	WRD	WRD	SRC	SRC	SRC	SRC
El Salvador	SAD	WAD	SRC	WAD	SAD	WAD	SRC	WRD
Guatemala	SAD	SRC	SRC	SRC	WRD	WRD	SRC	SRC
Haiti	n.d.	n.d.	n.d.	n.d.	SRD	SAD	SRC	WRD
Honduras	SRC	WAD	SRC	SRC	SAD	WRD	SRC	WRD
Mexico	SRC	WAD	WRD	WRD	SRC	WRD	WAD	WRD
Nicaragua	SRC	WRD	SRC	WRD	SAD	WRD	SRC	WRD
Panama	WAD	WAD	WRD	WAD	SRC	WRD	SRC	WRD
Paraguay	SRC	WAD	WAD	WRD	SRC	WRD	SRC	SRC
Peru	SAD	WRD	WAD	WAD	SRC	WRD	SRC	SRC
Dominican Republic	SRC	SAD	WRD	WRD	WAD	WAD	WRD	WAD
Uruguay	WRD	WRD	SAD	WRD	WRD	WRD	WRD	WRD
Venezuela (Bolivarian Republic of)	SAD	SRC	WRC	SAD	SRC	WAD	WAC	SRC
Latin America (19 countries)	WRD	WRD	SAD	WRD	SRC	SRC	WRD	SRC
Germany	SRD	SAD	WRD	SAD	WAC	WRD	WRD	WRD
China	WAD	WAD	WAD	WAD	WRD	SRC	WRD	WRD
United States	SRD	WAD	SRC	SAD	SRD	WAD	WRD	WAD
Russian Federation	SAD	WRD	SRD	SAD	SRC	WRD	SAC	SRC
India	WRD	WRD	WRD	WRD	SRC	WRD	WRD	SRC
Japan	SRD	SAD	SAD	SAD	SRD	WRD	SAD	SAD
Republic of Korea	SAD	WAD	SAD	SAD	WRD	WRD	WRD	WRD
European Union (28 countries)	SRD	SAD	WRD	SAD	SRD	SAD	WRD	SAD

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of official information from the countries; World Bank, DataBank [online database] https://databank.worldbank.org/data/home.aspx; International Energy Agency (IEA), "Detailed CO_2 estimates", IEA CO_2 Emissions from Fuel Combustion Statistics [online database] https://doi.org/10.1787/data-00429-en [accessed on: November 2018]; and International Transport Forum (ITF), "Road accidents", ITF Transport Statistics [online database] https://doi.org/10.1787/g2g55585-en [accessed on: November 2018].

Note: Income given in GDP in dollars at constant 2010 values; the abbreviations SAD, WAD, SRD, WRD, SAC, WAC, SRC and WRC and the colours indicate whether the decoupling (D) or coupling (C) is strong (S) or weak (W) and absolute (A) or relative (R); n.d. = no data.

Table A1.2
Latin America (19 countries) and other economies: elasticity and intensity of traffic accident fatalities with respect to income, 2007, 2010, 2013 and 2015
(Intensity measured in numbers of traffic accident fatalities per each 100 million dollars in constant 2010 values)

	Elasticity (E_i)				Intensity (I_i)				
	2007–2010	2010–2013	2013–2015	2007–2015	2007	2010	2013	2015	Change
Argentina	-0.8	0.3	6.9	-0.2	1.4	1.2	1.1	1.2	-16.4
Bolivia (Plurinational State of)	1.4	2.1	-3.5	0.5	6.2	6.6	8.0	5.1	-18.7
Brazil	1.1	-0.1	2.9	0.2	1.9	1.9	1.8	1.7	-13.5
Chile	-0.4	0.1	0.3	0.0	0.8	0.7	0.6	0.6	-23.4
Colombia	-0.3	0.8	1.4	0.6	2.2	1.9	1.9	1.9	-10.9
Costa Rica	-2.2	0.8	3.1	0.4	2.1	1.6	1.5	1.8	-13.7
Cuba	0.0	-1.0	2.2	0.2	1.7	1.5	1.3	1.4	-16.1
Ecuador	2.2	-0.4	0.4	0.5	4.2	4.8	3.7	3.6	-14.5
El Salvador	-6.0	-0.2	2.3	-0.3	6.6	5.7	5.1	5.4	-18.3
Guatemala	-3.6	6.5	1.2	2.3	2.4	1.8	3.3	3.4	39.2
Haiti	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Honduras	2.6	-0.9	3.2	1.1	6.8	7.5	6.1	7.1	3.3
Mexico	10.9	-0.5	0.2	0.3	1.5	1.6	1.4	1.3	-10.3
Nicaragua	2.1	0.1	1.7	0.8	6.2	6.5	5.5	5.9	-5.1
Panama	0.0	-0.3	0.8	0.0	1.7	1.4	1.0	1.0	-42.3
Paraguay	2.3	-0.2	-0.4	0.7	5.1	6.1	5.1	4.6	-10.0
Peru	-1.2	0.5	-0.9	-0.4	2.8	1.9	1.8	1.6	-44.0
Dominican Republic	1.6	-1.1	0.2	0.3	3.7	3.9	3.2	2.8	-22.9
Uruguay	1.0	0.2	-3.2	0.2	1.4	1.4	1.2	1.1	-23.5
Venezuela (Bolivarian Republic of)	-48.2	1.2	0.1	-5.0	1.9	1.6	1.6	1.7	-8.3
Latin America (19 countries)	0.8	0.1	-3.9	0.3	1.9	1.8	1.7	1.6	-13.0
Germany	42.8	-1.9	1.0	-4.7	0.1	0.1	0.1	0.1	-35.2
China	-0.8	-0.4	-0.1	-0.5	1.8	1.1	0.8	0.7	-63.3
United States	36.7	-0.1	1.4	-1.5	0.3	0.2	0.2	0.2	-22.3
Russian Federation	-16.4	0.2	7.3	-3.7	2.2	1.7	1.6	1.4	-37.1
India	0.7	0.1	0.4	0.5	8.6	8.1	6.9	6.3	-26.1
Japan	5.4	-3.6	-3.2	-12.5	0.1	0.1	0.1	0.1	-28.8
Republic of Korea	-1.2	-0.9	-1.6	-1.2	0.6	0.5	0.4	0.4	-41.4
European Union (28 countries)	16.6	-12.6	0.2	-13.4	0.2	0.2	0.2	0.1	-41.6

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of official information from the countries; International Transport Forum (ITF), "Road accidents", ITF Transport Statistics [online database] https://doi.org/10.1787/g2g55585-en [accessed on: November 2018]; and World Bank, DataBank [online database] https://databank.worldbank.org/data/home.aspx.

Note: Income given in GDP in dollars at constant 2010 values; n.d. = no data; elasticity values in bold if $E_i \geq -1$ or $E_i \leq -1$ and cells in green when elasticity is negative; cells are also marked in green when intensity falls over the previous year and if the change in intensity between 2015 and 2007 was negative.

Table A1.3
Latin America (20 countries) and other economies: elasticity and intensity of CO_2 emissions of the roads subsector with respect to income, 2007, 2010, 2013 and 2015
(Intensity in tons of CO_2 equivalent per million dollars in constant 2010 values)

	Elasticity (E_i)				Intensity (I_i)				
	2007–2010	2010–2013	2013–2015	2007–2015	2007	2010	2013	2015	Change
Argentina	0.2	0.7	14.6	0.6	97.0	91.4	89.6	91.5	-5.7
Bolivia (Plurinational State of)	1.5	1.6	0.9	1.4	244.2	259.5	288.7	284.4	16.5
Brazil	1.1	2.6	1.7	1.7	67.2	67.8	78.0	76.3	13.5
Chile	1.5	1.1	0.4	1.1	83.4	86.5	87.4	85.4	2.4
Colombia	-0.1	1.8	0.6	1.0	80.1	72.5	81.8	79.6	-0.5
Costa Rica	0.8	0.8	1.1	0.9	122.6	120.7	117.6	118.6	-3.3
Cuba	-5.0	-0.1	1.5	-1.5	30.3	18.8	17.1	17.6	-41.8
Ecuador	2.3	1.0	3.1	1.7	149.6	171.1	171.9	186.3	24.5
El Salvador	-3.1	-0.8	4.5	0.4	177.1	162.6	138.9	161.6	-8.8
Guatemala	0.5	0.3	2.8	1.2	142.1	137.9	128.3	148.4	4.4
Haiti	9.4	-1.6	10.9	0.5	192.8	166.1	120.1	179.5	-6.9
Honduras	-1.2	0.9	2.5	0.9	213.1	189.4	187.5	207.0	-2.9
Mexico	6.0	0.0	-0.1	0.2	133.8	138.5	127.2	119.3	-10.8
Nicaragua	-1.6	0.8	2.4	0.9	178.9	159.8	153.8	175.1	-2.1
Panama	1.4	0.1	1.7	0.8	111.9	118.9	93.6	100.8	-10.0
Paraguay	1.6	0.4	1.9	1.2	196.1	214.7	195.4	208.8	6.5
Peru	2.1	0.7	1.7	1.4	90.7	111.2	105.0	109.0	20.1
Dominican Republic	-0.4	-0.4	0.2	-0.2	96.2	81.5	70.0	62.2	-35.3
Uruguay	0.9	0.7	0.8	0.8	77.7	77.0	74.1	73.6	-5.3
Venezuela (Bolivarian Republic of)	28.7	-0.8	-0.3	3.7	110.0	122.6	101.0	114.5	4.1
Latin America (20 countries)	1.1	1.0	0.9	1.1	94.5	95.2	95.5	95.4	1.0
Germany	-0.7	0.7	0.9	0.9	41.3	41.8	41.3	41.1	-0.5
China	0.8	1.1	0.9	1.0	79.8	75.9	78.6	77.6	-2.7
United States	10.2	-0.2	0.7	-0.3	102.6	97.0	90.8	89.5	-12.7
Russian Federation	11.8	0.2	-2.0	2.3	79.8	92.7	85.1	90.7	13.7
India	1.5	0.9	0.9	1.1	95.7	106.2	104.4	102.7	7.3
Japan	1.7	0.1	-2.3	-3.1	34.6	34.0	33.0	31.2	-9.9
Republic of Korea	0.1	0.7	0.8	0.5	82.4	75.5	73.4	72.7	-11.7
European Union (28 countries)	3.2	-3.4	0.8	-2.2	52.9	50.7	47.5	47.1	-11.0

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of official information from the countries; International Energy Agency (IEA), "Detailed CO_2 estimates", IEA CO_2 Emissions from Fuel Combustion Statistics [online database] https://doi.org/10.1787/data-00429-en [accessed on: November 2018]; and World Bank, DataBank [online database] https://databank.worldbank.org/data/home.aspx.

Note: Income given in GDP in dollars at constant 2010 values; elasticity values in bold if $E_i \geq -1$ or $E_i \leq -1$ and cells in green when elasticity is negative; cells are also marked in green when intensity falls over the previous year and if the change in intensity between 2015 and 2007 was negative.