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Road transport externalities in Mexico: Estimates and international comparisons

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ABSTRACT

In Mexico, as in many developing countries, no monetary estimates of road transport externalities exist. The abundant empirical evidence from the developed world appears to show such research reaching maturity. Yet, several barriers to deriving basic estimates among developing countries persist. In this study, we addressed such difficulties for the Mexican context, and by pooling the available data and using well-established methods, we calculated six categories of estimates. The results showed that road transport externalities amount to at least 59.42 (44.8–73.97) billion US dollars per year or 6.24% (4.71–7.77%) of GDP. By component, accidents represented the largest share (28%), followed by congestion (22%), greenhouse gases (21%), air pollution (13%), infrastructure (7%), and noise (9%). By vehicle type, cars had the highest costs per pkm, and buses had the highest costs per vkm. The costs of road transport externalities in Mexico ranked between those of developed and developing regions, but we found some notable differences when comparing the impacts per pkm of the four largest externalities. We discuss such differences and the policy implications of our findings. We also provide suggestions for future research.

1. Introduction

In most developed countries, research on road transport externalities has reached maturity. There is an abundant literature on the subject, in which negative externalities have been recognised as the most important (Rothengatter, 1994). For the EU, results are available at the local and national levels (Cendero, 2011; Monzon and Guerrero, 2004) for individual (IER, 1996) or multiple effects (Mayeres et al., 1996), and even on a periodic basis (INFRAS/IWW, 2004, 2000). For Japan and the US, despite there being less research, the progress is rather similar (Delucchi and McCubbin, 2010; Forkenbrock, 1999; Koyama and Kishimoto, 2001). A general consensus is emerging on the proper methodologies for producing such estimates and has been summarised in some publications (INFRAS et al., 2007; Hensher and Button, 2003). Yet, all this contrasts with the reality in the developing world.

For less developed countries, several barriers still exist to arrive at even rough estimates. The most critical are the quantity and quality of the data and the applicability of some of the available methods. Nevertheless, an emerging literature is producing marginal (Guo et al., 2010; Sen et al., 2010) and total estimates (Bell et al., 2006; Zegras, 1998), but research into developing countries remains in its infancy.

The estimation of externalities is an essential task for any market-driven economy, as it represents the first step to adjust for "real" prices. It is useful to more efficiently provide transport services and inform policymakers regarding the best options for expanding transport. Current transport activity, however, appears to grow without particular concern for such effects, especially among developing countries, where the biased promotion of one or more transport forms is common. One example of this is Mexico, a country where road activity has grown unchallenged by other modes.

Mexican road transport has been a pillar of most official development plans. Beginning in the 1930s, the growth of road transport has been encouraged by the expansion of North American and Mexican automotive industry (Gonzalez Gomez, 1990). It had overtaken railways for passenger transport by the 1950s and for freight by 1980. Subsequently, in the preamble of NAFTA, it was further promoted when high performance highways were extended from 4000 km to more than 8000 km (SCT, 2010). As a result, by 2004, its added-value reached 123.81 billion pesos, becoming the third most important at the national level (IMT, 2006).

Simultaneously, the negative impacts of road transport increased steadily. It became the largest source of CO_2 emissions and the largest emitter of air pollutants among end-use sectors (CICC, 2006). Road transport has come to dominate the transport sector (76% of freight and 99.3% of passenger trips in 2006), which

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has become highly dependent on fossil fuels (97% of the total energy for transport) (IMT, 2006). Mexican road transport grew to a far greater extent than other modes, providing several benefits but also creating externalities and economic inefficiency within the sector. Those externalities, however, have never been analysed.

An analysis of the externalities of Mexican road transport is still lacking. An early publication by El Colegio de Mexico mentioned that the annual congestion costs in Mexico City were equivalent to 1400 million dollars per year (Guzmán et al., 1985). More recently, Parry and Timilsina (2010) extrapolated external costs from the USA to analyse optimal passenger travel prices in the Mexico City. Yet, the true external costs remain unknown. The growing interest in externalities among policy makers in developing countries and the limited literature on the subject may overlook the persistent multiple challenges and obstacles to deriving robust estimates.

The aim of this article, therefore, is to estimate total and average Mexican road external transport costs in six categories (air pollution, climate change, noise, accidents, congestion and infrastructure), using well-known methodologies and local data. In the process, we review the difficulties associated with the Mexican context, compare our results with other developed and developing regions, discuss the policy implications of the findings and provide an agenda for future research.

2. Methods

The external costs of road transport can be distinguished between total-average and marginal costs. Marginal costs are obtained by considering detailed data on spatial conditions, vehicle types, and regional driving patterns, while total and average costs are derived using data from national statistics divided per mode of transport. We focused on total and average costs, as this is the only method suitable for the available data.

We selected six cost categories for this analysis, representing more than 90 percent of the total external costs in most studies (Cendero, 2011; INFRAS/IWW, 2004, 2000). These were air pollution, climate change, noise, accidents, congestion, and infrastructure. In the following subsections, we will briefly explain the methods used. For a more detailed description of our assumptions, refer to Appendix A.

2.1. Air pollution

The impacts from vehicle emissions, such as particulate matter (PM), nitrogen oxide (NO), sulphur oxide (SO) and volatile organic compounds (VOC), are responsible for the external costs of air pollution. We focused on the health effects caused by road transport-related PM_{10}, applying the method developed by Kunzli et al. (1999) to Mexican data. Specifically, we followed Koyama and Kishimoto (2001) in extending this method to Mexico, as they already replicated it for Japan. Air pollution has several additional impacts. However, health effects appear to be the most important (INFRAS et al., 2007; ECMT, 1998). Health damage from other emissions, property damage or other impacts were not included due to data limitations.

We used three basic parameters to estimate these costs: the average annual density of PM_{10}, the annual mortality from air borne diseases, and the cost factor. Other parameters were assumed from previous studies, such as background concentrations, the increased mortality risk, and the road traffic component of PM_{10} emissions.

2.2. Greenhouse gases

Greenhouse gas emissions in the form of CO_2, N_2O and CH_4 are the source of global warming and climate change. The release of these gases is responsible for several impacts, such as sea level rise, agricultural loss, water supply problems, health effects from temperature change, etc. (INFRAS et al., 2007). To estimate the external costs of such impacts, two basic parameters were necessary: road transport related emissions and a cost factor per ton of equivalent CO_2 emissions. We used transport related emissions from national statistics and previously reported cost factors extrapolated to Mexico.

2.3. Noise

Noise from road traffic is the main impact in this category. Noise pollution is most commonly evaluated based on three variables: the levels of average constant noise from road traffic, the population exposed to such noise, and a cost factor per dB over the threshold (Koyama and Kishimoto, 2001; INFRAS/IWW, 2004, 2000). Cost factors can be determined from noise annoyance or health effects, assessed together or separately, and using revealed or stated preference methods. We considered rural and urban areas separately, making use of the few Mexican studies that reported noise levels. We employed both high and low estimates of population exposure, and we derived a cost factor assuming that property depreciation rates from noise in Mexico are similar to those in Europe.

2.4. Accidents

The social costs from road traffic accidents are the main impacts in this category, specifically, those not covered by risk oriented insurance premiums (INFRAS et al., 2007). Some reports note that a share of these impacts is internal, but such risks are generally considered too small to influence modal choice (INFRAS/IWW, 2004). Thus, the primary factors in this estimation are the following: the costs of fatalities, injuries, material damage, and other damages. In addition, following several papers (Koyama and Kishimoto, 2001; INFRAS/IWW, 2004, 2000; ECMT, 1998), this study deducts insurance payments from the total external costs, as they are considered gratification payments or a transfer of liability on the part of the responsible party.

The cost factors in this category are those associated with economic estimates of the effects of fatalities and injuries. Two methods exist for their estimation: one focusing on the grief or pain from the loss of a human life using willingness to pay (WTP) surveys, and another considering the forgone economic output due to the loss. The health costs associated with fatalities and injuries are either considered a component of this value or estimated separately, and material and other damages, as well as the amounts of insurance claims, are usually obtained from the relevant statistics.

In this study, we used data on fatalities, injuries, and insurance compensations from national databases and assumed both the proportions for severe and slight injuries and all of the cost factors.

2.5. Congestion

The essential problem of congestion is the time lost due to the mutual disturbance among users of an overburdened infrastructure. Congestion can also be related to other externalities such as air pollution or greenhouse gases, but time delays are generally the most relevant effect (INFRAS et al., 2007). Congestion costs are often the most well studied externality, as road pricing is typically based on them.

Our approach focused on time delays, and we distinguish between those in urban and interurban areas to overcome certain difficulties in the analysis. For urban areas, we modelled Mexico City separately, using an origin-destination survey (IGECEM and SETRAVI, 2007). The occupancy rates employed came from other Latin American cities. The cost factor used was in terms of the local hourly wage (Small and Verhoef, 2007; Parry and Timilsina, 2010).