The external costs of private versus public road transport in the Metropolitan Area of Santiago, Chile

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ABSTRACT

We estimate marginal external costs per kilometer for car and bus in the Metropolitan Area of Santiago, Chile, in terms of congestion, road damage, accidents, air pollution and noise. Estimates are provided for both peak and off-peak periods. To carry out our analysis, we collected and integrated the output of several local studies. These estimates should contribute to a better debate on how to manage efficiently motor vehicles externalities by means of both (pigouvian) tax instruments, public transport subsidies and regulation. We also offer a comparison of our results with those reported in the literature.

At peak times, marginal external costs per kilometer for petrol cars, diesel cars and buses are estimated at USD 0.51, USD 0.53 and USD 1.80 respectively. When these values are converted to passenger-kilometer, petrol cars, diesel cars and buses impose a marginal external cost of USD 0.41, USD 0.42 and USD 0.04 respectively. At off-peak times, all these values are reduced as congestion decreases significantly. The marginal external cost for petrol cars, diesel cars and buses are USD 0.15, USD 0.16 and USD 0.78 respectively. Differences in marginal external costs per passenger-kilometer between cars and buses shrink as these costs fall to USD 0.12, USD 0.13 and USD 0.05 for petrol car, diesel car and bus respectively.

1. Introduction

Metropolitan urban transport produces several negatives externalities, among others, congestion, road crashes, air pollution, noise and spatial segregation. Drivers usually pay (fuel) taxes, but these are not necessarily designed to provide adequate incentives to internalize external effects. Hence, drivers generate negative externalities beyond their optimum level, negatively contributing to social welfare. The aim of this research is to shed light on the likely magnitudes of the marginal external costs of road transport in the Metropolitan Area of Santiago, the capital city of Chile. Estimating these marginal external costs should be a most relevant input for policy makers to device regulations and market instruments that contribute to a more sustainable urban transport.

To optimally manage the external costs of transport, we need to understand (i) how users’ equilibrium take place in urban transport markets, (ii) how this equilibrium affects transport externalities and (iii) how to monetize all these impacts. Having determined the external costs, pigouvian taxes could be designed. With proper internalization, a new users’ equilibrium would arise and externalities would be produced at their optimal level. Parry and Small (2005) show how to integrate...
different urban transport externalities in a microeconomic model that can determine the optimal fuel tax in a second best setting, when other distortions in the economy are present.

There exists a profuse literature dealing with these topics with contributions from both a theoretical and an empirical standpoint. Regarding transport externalities among road users, the three most relevant externalities are travel delays brought about by congestion, road damage and accidents (Newbery, 1994). The economics of travel delays has been studied since the nineteen-fifties: very good reviews of different models of urban road congestion (from simple to complex treatments) are Small (1992) and Small and Verhoef (2007). Newbery (1988, 1989) developed models to address road damage externalities. Vickrey (1968) was the first (up to our knowledge) to deal theoretically with road accident externalities. More recently, Jansson (1994) and Lindberg (2001) provide a rigorous and more complete treatment of accidents externalities.

Other road externalities include air pollution, greenhouse effects, noise, barrier effects, among others. In particular, air pollution has been extensively studied by epidemiologists, who have shown that as air quality deteriorates, health outcomes worsen in terms of both mortality and morbidity (Pope and Dockery, 2006). As we know from national emission inventories (DICTUC, 2007) road transport is among the main polluters contributing to deteriorated air quality. Transport models that predict traffic flows and average speeds on network links could be used to estimate vehicles emissions of air pollutants and noise. Instead, barrier effects are one of the less well-studied environmental impacts associated with transport infrastructure. The time lost by pedestrians or vehicles for crossing transport infrastructure (e.g. rail tracks) could be one very crude measure. More important, these barrier effects refer to the separation of people from facilities, services and social networks within a community, and/or people changing travel patterns due to the physical or psychological barriers created by transport corridors and their use (Grisolia et al., 2015). Its valuation has been systematically ignored or underplayed in transport planning and environmental impact assessment (Handy, 2003).

Having established the link between car usage and externalities, the next step in terms of economic analysis is their monetization. Basically we need estimates of the value of travel time savings, the value of life and limb, the value of quietness, etc. As these hedonic goods are not sold in markets, there is a need to estimate them by means of statistical analyses. Freeman (2003) is a classical textbook in the valuation of non-market goods. Regarding the valuation of transport externalities, people must not only be aware of the externality impacts, but they must also have a clear understanding of its negative welfare effects and be able to express consistent preferences for trading them off against money or other goods. It appears reasonable to postulate that some local externalities, such as traffic congestion, noise, the risk to life and limb fall into this category since they affect people’s welfare on a daily basis (Nash, 1997). Hensher and Button (2003), Ortuzar and Rizzi (2006) and De Palma et al. (2011) contain several studies designed for the valuation of many local transport externalities. The valuation of global externalities from people’s preferences such as greenhouse effects, and thus carbon dioxide (CO2) emissions, should be a much more difficult task. As these effects are less clear, sometimes not perceived at all, people are not able to express consistent preferences for their trade-offs. Nonetheless, efforts have been made to estimate the social costs of carbon from a bottom up perspective. For a review on the estimation of the social cost of carbon refer to Tol (2009).

As to reviews of external costs of transport, we mention just a few. Maddison et al. (1996) deal extensible with the external costs of road transport in the UK and present case studies from Sweden, North America and the Netherlands. The externalities analyzed are greenhouse effects, local air pollution, noise pollution, congestion, road damage and accident costs. They also provide a catalogue of estimates of external costs in the annex of the book. Delucchi (2003) reviews estimations of external costs of air pollution, climate change, noise and water pollution for the United States at the national level. Small and Verhoef (2007) compile empirical evidence on the external cost of road accidents and of two environmental externalities: local pollution and the greenhouse effect. Delucchi and McCubbin (2011) and Friedrich and Quinet (2011) report estimates of external costs of transport for different regions of the United States and Europe respectively. The first article covers congestion, accident, air pollution, climate change, noise and water pollution and energy-security costs at the national level; the second article also considers landscape effects. INFRAS/IWW (2000) and CE Delft/INFRAS/ISI (2011) provide estimates for several transport externalities for countries of Western Europe in a very comprehensive effort.

From our analysis, we conclude there is consensus on the plausibility of monetizing at least four urban road transport externalities: travel delays road, accidents, air pollution and noise. Road damage is also feasible to monetize, albeit most of the revised material ignores it.

In this research, we proceed to monetize the external impacts of travel delays, road damage, road accidents, air pollution and noise of both car and bus for Metropolitan Santiago, Chile. Specifically, we will estimate the marginal external costs in terms of vehicle-km and in terms of passenger-km for peak and off peak periods. In this respect, our study is of a very similar nature to Sen et al. (2010) who estimate the marginal external costs of road transport for Delhi, India. Our advantage with respect to Sen et al. (2010) is that we have a wealth of local data and local studies at our disposal, so our estimates depend much less than theirs on transferred values. Our study also offers contrasting results to those produced by Parry and Strand (2012) on what the optimal level of fuel taxes should be for Chile. Although our study is at a metropolitan level and theirs at a national level, we clearly demonstrate how different assumptions lead to very different estimations of external costs, casting doubts on the applicability of Parry and Strand (2012) results for policy making.

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1 The economic literature abounds with theoretical treatments of externalities and case studies of valuation of externalities. The review to be presented in this article is by no means an extensive one. In our limited review, we tended to select some ‘classical’ books and/or material from transport-related handbooks when available.
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