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Managing transportation externalities in the Pyrenees region: Measuring the willingness-to-pay for road freight noise reduction using an experimental auction mechanism

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ABSTRACT

The estimation of the noise impact caused by road freight transportation is critical to have acknowledgment of the ambiance pollution caused by road traffic crossing geographical areas containing important natural resources. Thus, our work proposes a within-subject survey where a Contingent Valuation Method (CVM) is combined with a laboratory economic experimental auction. Our study objective is to measure the willingness-to-pay (WTP) for reducing traffic noise nuisances due to freight transportation in the region of Navarre, Spain. A special focus is made regarding the measurement of the hypothetical bias, when a comparison is done between hypothetical WTP, coming from the CVM study, with real-incentivized one, as the outcome of the economic experiment. Additionally, statistical analyses are conducted in order to find explanation factors for these outcomes. Results suggest a strong evidence for an upward hypothetical bias (from 50% to 160%) indicating the income, the educational level, the gender, and the age as the main factors which explain that bias.

1. Introduction

After the industrial revolution, freight transportation became a key sector in industrialized countries, as a basic determinant for economic and social activities. This key role of transportation has been enhanced in the European Union during the period 1990–2015 with the development of new transportation regulations. The transportation main function is connecting consumers and producers by promoting specialization and accessibility to a wide variety of merchandises. Moreover, from the social point of view, the importance of leisure-related activities makes transport an essential action for human relationships development.

Furthermore, time and cost savings, among others, are the direct benefits derived from freight transportation system, which presents a greater interest in transport literature. However, the real cost of moving freight from the raw material sources, the manufacturing or distribution centers and to consumers is borne not only by the stakeholders, such as logistic company owners, but also by other members of society who may not benefit directly from these movements. In the economic literature, this is known as negative externalities (Demir et al., 2015). Additionally, following some meaningful authors (Xiao et al., 2012; Demir et al., 2014; Perveen et al., 2017), the consideration of this kind of nonconventional costs has traditionally been scarce and its analysis has not reached the depth that its significance would be advisable.

Negative externalities are particularly significant in road transportation crossing geographical areas of special natural value. One of these areas are the Pyrenees in Europe, natural border between Spain and France, which has also a high density of road traffic, mainly trucks. In fact, more than 140,000 vehicles cross daily the Pyrenees (circa 90% using the two main motorways which reach the border in Irún-Behovia and La Junquera, Western and Eastern extremes of the mountainous range respectively), being freight trucks almost 30,000 of them (Spanish-French Observatory of Pyrenees Traffic, 2015). Moreover, the noise and air pollution costs are, at least, four times higher in mountainous areas in comparison with flat areas (INFRAS, 2017). Similarly, Demir et al. (2015) listed some negative externalities associated to freight transportation such as noise or air pollution (mainly CO_2 emissions). Thus, these authors

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provided a selection of models to measure, at different levels of accuracy, their impacts in terms of decibels, in the case of noise, or fuel consumption, when estimating CO_2 emissions. Nevertheless, there is not enough literature to reach a consensus regarding the economic values of these freight transport externalities since the valuation processes are data-intensive and requires a good deal of subjective judgement (McKinnon et al., 2015).

These economic values are indeed a necessity if public authorities want the implementation of cost-benefit analyses in possible regulations, levels for taxes and subsidies, or in transport infrastructures investments. In this case, implementing efficient transport systems need proper adequate assessment of external costs, as optimal transport policies imply necessarily the computation of adequate social marginal costs, as the sum of marginal private costs and of marginal external costs (Nijkamp et al., 2003; Willis, 2005). Likewise, it is necessary to consider that there are many different ways to assign monetary values to externalities, but most of them followed the methodology called 'Damage Function Approach' (Adamowicz, 2003) that assumes that the externality damage has already been done. However, in most cases, the damage caused by logistic activities in the environment cannot be directly observed. This is often developed using the so-called 'Impact Pathway Approach' (European Commission, 2003). This scheme begins with the calculation of emissions originated from logistic activities, tracking their diffusion and, in the case of gases, their chemical conversion and concentration at different spatial scales. Usually, the following step is a review of the receptors' response, such as people, animals, vegetation, physical objects, to these emissions. These responses will normally be negative, representing a welfare loss. Hereafter, those losses have to be quantified and translated into monetary values to consider them into public decision-making processes during the implementation of transport policies.

Overall, there are two valuation methods in externalities costs estimations (Boyle, 2003). The first one is related to Revealed Preference (RP) studies in which an environmental cost is inferred from current changes in people's behavior (using, for example, the hedonic pricing methods, see e.g., Andersson et al., 2010). The second one is the Stated Preference (SP) surveys, in which participants are asked for their willingness-to-pay (WTP) in order to remove an externality, or at least to mitigate its negative effects. The WTP methodology looks for the maximum monetary amount that an individual is willing to pay to avoid an undesirable event (Wang et al., 2018; Bazrbachi et al., 2017). The Contingent Valuation Method (CVM) is often used, consisting in a stated-preference technique in which respondents are asked for their willingness to pay to pass from a current environmental scenario to a contingent (hypothetical) one with better environmental characteristics.

The CVM, however, presents some drawbacks due to the fact that the survey context could be considered to be artificial because the respondents' real WTPs may be different from what they are answering. Concerning this methodology, there had been a large discussion in the literature regarding the concept of "hypothetical bias" that states a potential gap between real and hypothetical individual economic valuations (Murphy et al., 2005). Carson and Groves (2007) have argued that the correct opposition between methods is about the consequences of the survey. Actually, as defined by Carson and Groves (2007), a survey is 'consequential' if (i) the agent answering a preference survey question must view their responses as potentially influencing the agency's actions, and (ii) the agent needs to care about what the outcomes of those actions might be. If one of the previous conditions is absent, then the survey is 'inconsequential'. It could be disputable to consider that stated preference in a CVM survey are really consequential, given that participants do not know precisely how, when and how much the possible policies/actions will impact their personal situation regarding the peculiar problem they are asked about. Nevertheless, these possible consequences are rarely explicitly and precisely stated for respondents. In order to cope with an explicit and precise consequence, it is used the experimental economics method for two reasons. The first one is the implementation of immediate and real outcomes (money) for noise reduction scenarios depending on participants' choices. The second one is to enable a group decision-making process for resources that should be used for increasing a public commodity related to noise mitigation. On one hand, the motivation of the current study is based on the importance of noise in road transportation and its difficulty of estimation of the payment for the noise abatement in areas of great environmental impact as the Pyrenees Mountains. On the other hand, the main contribution is that, to the best of authors' knowledge, this paper is the only one to use an experimental auction procedure that guarantees incentive compatibility to measure willingness-to-pay for freight noise reduction. Actually, as explained by Cummings et al. (1997): "An allocative mechanism or institution is said to be incentive compatible when it rules provide individuals with incentives to truthfully and fully reveal their preferences". In a laboratory economic experiment in the UPNA (Public University of Navarre) premises, respondents were endowed with real money that actually was paid as their WTP. It also enables us to make a comparison of this experiment with the results of a Contingent Valuation Survey by implementing a within-subject analysis. Trying to give a first insight of the results, it is found that respondents exhibit a significant hypothetical bias, that is to say a hypothetical WTP being much greater than real WTP, and that a minor but significant part of them are zero protesters. Additionally, several explanatory variables of this bias have been identified and analysed. Thus, this paper is structured in the following way: Section 2 reviews the related literature with transport externalities and their corresponding WTP; while Section 3 presents all the details of our survey design. Additionally, Section 4 provides the empirical results related to the survey and Section 5 performs the results discussion. Finally, Section 6 provides the concluding outcomes.

2. Literature review

Research interest in freight transportation externalities has continuously expanded because of the increasing impacts on economy, environment, climate, and society. For example, Ranaiefar and Regan (2011) classified truck negative externalities in the four groups: firstly, social externalities, which include noise pollution, accidents and visual intrusion; secondly, economic externalities that address congestion, road damages, and longer travel times; thirdly, ecologic externalities, which account for climate change and biodiversity destruction; and finally, environmental externalities for air pollution, water pollution and waste products. For a deeper description on main negative road freight transportation externalities, the reader is referred to Demir et al. (2015), who present a painstakingly analysis of the main transport externalities.

A large set of methods can be considered in order to measure stated or revealed values regarding non-market goods, e.g., nuisances, such values being either a willingness-to-pay to obtain a certain reduction of damage level or a willingness-to-accept a certain increase in this damage level (Horowitz and McConnell, 2003). Other important references related to noise pollution caused by activities related to transportation are Malvestio et al. (2018), Rajeev et al. (2017), and Sen et al. (2017).