Valuing Road-Transport Noise Abatement Measures

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1 Introduction

Transport noise is a costly affair. Substantial noise-levels can cause annoyance, stress and illness. According to a European report (CE Delft et al., 2011), the external cost of noise induced by road transport in Europe[1] amounts to 17 Billion euros annually. In Europe the Environmental Noise Directive [2] aims to reduce harmful noise-exposure of citizens. Without specifying limit noise-values, this directive still incentivizes governments to devise policy-measures against noise. The main goal of noise-abatement policy measures is to minimize the external costs of noise, arising in the absence of a market for tranquility. In the Netherlands these external costs may, partly, be mitigated by road- and fuel taxes (Andersson and Ögren, 2013), in combination with policy measures such as silent tires, silent tarmac, traffic management systems (TMS), highway sound-barriers and housing-insulation (RIVM, 2001).

Within this maze of policy-measures and different taxes, it seems difficult to evaluate the current situation in the Netherlands against the socially optimal outcome, where the

[1]EU27 excluding Malta and Cyprus, including Norway and Switzerland.
[2]European Commission, 2002. Environmental noise directive 2002/49/EG.

marginal costs of abatement (e.g. construction costs of sound barriers, implementation costs of TMS etc.) equal the marginal benefit of abatement (i.e. marginal willingness-to-pay for noise reduction). The objective of this paper is to develop a framework from which the economic efficiency of transport-noise policy measures can be evaluated. Section 2 gives an overview of the current academic debate concerning noise-abatement policy, section 3 elaborates on strategies to estimate the willingness-to-pay for noise reduction, section 4 deals with the different cost types associated with policy measures and section 5 concludes.

2 Noise-abatement policy

Since the 1920s, the first-best solution to external costs in motoring is generally regarded to be a road-pricing scheme that charges drivers the marginal external costs they impose on others (in terms of congestion, environmental damage, noise etc.) (Pigou, 1924). Electronic Road Pricing (ERP) schemes can nowadays be used to charge motorists a regulatory fee that can be differentiated along many dimensions (trip length, vehicle type etc.) in order to reflect the appropriate marginal external costs imposed (Verhoef et al., 1995). Although ERP schemes are technically feasible nowadays, social and political issues prevent such a system from being introduced widely. When road-users are not taxed for the negative effects of the noise they produce this noise will be overproduced. Still, an array of policy tools is developed to tackle the problem of traffic noise.

The amount of noise that an individual vehicle produces depends on the vehicles technical construction (type of motor, tires etc.), driver characteristics (driving speed and style), and on the type of road surface. Source-based policy measures are designed to limit noise generation: restrictions on motor and tire noise are placed at the EU level[3], decisions on road surfaces (such as the implementation of silent tarmac) are made at a more local level. Traffic volume, the amount of lorries, and traffic speed affect

[3]European Commission, 2007. Vehicle type approval framework directive 2007/46/EC.

noise-levels greatly. Traffic-management systems influence the maximum speed and the flow of traffic and can therefore be used to limit noise-generation. Next to measures that limit noise-generation, the government can take steps in hampering noise propagation, through noise-barries walls and, ultimately through housing insulation. Measures that tackle noise-generation are generally considered to be more cost-effective than measures that hamper noise-propagation (Danish Road Institute, 2005, den Boer and Schroten, 2007).

3 Willingness-to-pay for noise reduction

As external effects are not (correctly) priced in the market, valuing these effects correctly poses a problem. Academic literature describes various solutions to the problem of estimating the value of external effects. Revealed-preference (RP) and stated-preference (SP) methods are the most frequently used tools in uncovering the willingness-to-pay/accept for external effects. Next to these methods some obscure methods, such as quality-of-life-surveys are used as a means to the same end (van Praag and Baarsma, 2001). This section describes in detail the two most common methods (RP and SP) and briefly touches upon more obscure and innovative methods.

3.1 Hedonic pricing methods

Valuing external effects with the use of revealed preference methods is possible in the presence of private markets that are complementary to externality-avoidance, such as the market for housing (Nelson, 2008). Theoretically, a discount for noise can be obtained through analyzing the market values of identical houses in an environment with, and an environment without noise. This implies that people with a lower willingness-to-pay for noise-avoidance will locate in noisy areas, and people with a high willingness-to-pay will locate in more quiet areas. The resulting equilibrium can be disturbed in case of (durable) shocks in noise-levels, in which case a new stable equilibrium will arise. In reality the characteristics-spectrum of a house is much more complex, and a noisy environment can be offset by other positive characteristics.

Rosen (1974) defines hedonic prices as

> ”. . . implicit prices of attributes (. . .) revealed (. . .) from observed prices of differentiated products and the specific amounts of characteristics associated with them.”

This entails that, in hedonic pricing models, the willingness-to-pay for a product is subdivided in terms of product characteristics and attributes. The 4 main assumptions for the operation of hedonic pricing analysis are defined by Bateman (1993):

1. Aggregate willingness-to-pay reflects the social benefit.
2. Environmental quality changes are perceivable, and they affect the future benefits from owning a property, thus people are willing to pay for these quality changes.
3. The area considered is a competitive market with free access and perfect information on prices and environmental quality.
4. The housing market is in always equilibrium.

An early hedonic pricing analysis of highway noise, done by Nelson (1982) specifies a model:

$$V = V(Q, Z) \tag{1}$$

In which P represents a vector of housing price observations, Q a vector of environmental quality characteristics, Q_j the inverse of noise-level, and Z a vector of all other housing characteristics. $\frac{\partial V}{\partial Q_j}$ then represents the marginal price tranquility. Evaluating $\frac{\partial V}{\partial Q_j}$ for different levels of Q_j results in an estimated price function of noise/tranquility. Noise sensitivity of housing prices is often evaluated by the Noise Depreciation Index (NDI) (Walters, 1975). For highway noise, Nelson (1982) defines the NDI as the difference in total percentage depreciation divided by the difference in noise exposure, for residential properties that differ only in terms of noisy environment.

Besides the obvious advantage of HP-studies that they are based on real-world choices, some drawbacks to this approach exist as well. Assumption 3 and 4 as defined above, for instance, are highly unlikely to be realistic: It is doubtful whether there is perfect information concerning housing prices and environmental quality among individuals, and the housing market seems plagued with market imperfections.

3.2 Stated preference methods

In stated preference studies, a market for the external effect is simulated, in order for respondents to state their willingness-to-pay/accept for marginal changes the externality. In the field of environmental economics stated preference contingent valuation (CV), as the values obtained are contingent on the specifications of the simulated market. Such specification include the rules of the market (bidding, preference ranking), the way the market for the environmental externality is realistically described (in case of noise: to which extent real sound is used) and the way in which the value is framed (out-of-pocket, tax increase etc.)(Carson and Hanemann, 2005). Although some scholars claim that the CV method is a distinct branch of stated preference techniques in that it only involves a singular change in the supply of an environmental good, and that it directly asks a monetary value from respondents (Wardman and Bristow, 2004), the current paper takes a somewhat broader definition of CV, based on Carson and Hanemann (2005), namely that any stated preference method that is used to estimate values for environmental goods can be characterized as a CV method.

An important advantage of CV studies is that they include non-user valuations of environmental goods, which is impossible in the HP method. Noise can, for instance, have adverse effects on nature-reserves, while these negative effects are not capitalized in housing prices. Disadvantages of the CV-approach are often due to the hypothetical nature of this type of studies. People might not reveal their true willingness-to-pay because of strategic response behavior. These surveys are often directed at valuing goods that have a public nature, which causes free-rider behavior on the part of the respondents. Another drawback is the possibility of protest-bids, where respondents state a willingness-to-pay of zero out of disagreement with, for instance, the setup of the question, while their willingness-to-pay is in fact non-zero.

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