

## Guidelines for the application of hedonic pricing method

We start from the assumption that real state prices depend on the characteristics of the considered property, hence

$$P = f(S, N, E) \quad (1)$$

where  $P$  is the price of the real estate property,  $S$  is a vector that captures its structural characteristics (area, number of bedrooms, number of bathrooms, floor height, existence of an elevator in the premises...),  $N$  is a vector that comprises neighborhood characteristics (safety, proximity to schools, public services, shopping centers...) and  $E$  is a vector that includes the environmental characteristics appreciated by the market, which are the object of the evaluation. Note that, while it is true that most hedonic pricing applications use real state transactions as data basis, any good whose characteristics are well known, including its environmental attributes, and for which there exists a smooth market, might also perform.

The most common specification used for equation (1) is semilogarithmic:

$$\ln P = B_0 + B_{S_1} \cdot S_1 + B_{S_2} \cdot S_2 + \dots + B_{N_1} \cdot N_1 + B_{N_2} \cdot N_2 + \dots + B_{E_1} \cdot E_1 \quad (2)$$

Let's assume that  $P$  reflects the price of apartments in a city and that  $E_1$  captures a given environmental quality attribute, be it air quality, silence, or views, measured in a suitable unit. It is expected that, other things equal, the prices of apartments with better environmental quality (larger  $E_1$ ) will be higher. The statistical estimation of the coefficients of equation (2), from a sufficiently large sample, makes it possible to quantify the effect on the price of apartments that is attributable to each of their characteristics (area, public services, etc.), including environmental quality from coefficient  $B_{E_1}$ .

More specifically, an improvement in environmental quality from  $E_1^0$  to  $E_1^1$ , all other characteristics remaining equal, will result in an increase in the price of apartments from  $P^0$  to  $P^1$ , corresponding to a growth rate  $g$ :

$$g = P^1/P^0 - 1 \quad (3)$$

From equation (2), it can be shown that the effect of an improvement in environmental quality considering (3), can be expressed as:

$$B_{E_1} \cdot (E_1^1 - E_1^0) = \ln P^1 - \ln P^0 = \ln (P^1/P^0) = \ln (1 + g) \quad (4)$$

Hence,

$$g = \exp(B_{E_1} \cdot (E_1^1 - E_1^0)) - 1 \quad (5)$$

If  $E_1$  is a dummy variable, for instance, the enjoyment of views over the bay where the town is located,  $E_1^1 - E_1^0 = 1$  and (5) can be reduced to a much simpler expression:

$$g = \exp(B_{E_1}) - 1 \quad (6)$$

Once this growth rate  $g$  is obtained, it can be used to estimate the economic value of the environmental attribute. The consistency of the model requires that the underlying markets

function correctly, mainly that there is mobility in the real estate market and that transaction costs, primarily those related to information on market conditions and the making of sales and purchases, are low. Sampling is generally cross-sectional, taking real estate data from purchase transactions taking place in a specific interval, and controlling for relevant changes. Given that the set of characteristics that influence the price of real estate is very broad, and that not all of them are orthogonal (independent of each other), it is advisable that the sample size be high in order to reduce the variance of the estimators. It is also advisable that the real estate considered in the sample be homogeneous so that potential hidden variables do not increase the variance of the estimators.