



HAL
open science

Measuring the social value of local public goods: an Empirical Analysis within Paris Metropolitan Area

Alessandra Michelangeli, Nicolas Gravel, Alain Trannoy

► **To cite this version:**

Alessandra Michelangeli, Nicolas Gravel, Alain Trannoy. Measuring the social value of local public goods: an Empirical Analysis within Paris Metropolitan Area. *Applied Economics*, 2006, 38 (16), pp.1945-1961. 10.1080/00036840500427213 . hal-00581888

HAL Id: hal-00581888

<https://hal.science/hal-00581888>

Submitted on 1 Apr 2011

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



**Measuring the social value of local public goods: an Empirical Analysis
within Paris Metropolitan Area**

Journal:	<i>Applied Economics</i>
Manuscript ID:	APE-04-0165.R1
Journal Selection:	Applied Economics
Date Submitted by the Author:	07-Feb-2005
JEL Code:	C49 - Other < C4 - Econometric and Statistical Methods: Special Topics < C - Mathematical and Quantitative Methods, D61 - Allocative Efficiency Cost-Benefit Analysis < D6 - Welfare Economics < D - Microeconomics, H41 - Public Goods < H4 - Publicly Provided Goods < H - Public Economics, R21 - Housing Demand < R2 - Household Analysis < R - Urban, Rural, and Regional Economics
Keywords:	hedonic, public goods

powered by ScholarOne
Manuscript Central™

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Measuring the Social Value of Local Public Goods: An Empirical Analysis within Paris metropolitan area

Nicolas Gravel*, Alessandra Michelangeli[†] and Alain Trannoy[‡]

(this version) January 15th 2005

Jel Classification Number: C4, D6, H4, R2

Abstract

We use a non-linear hedonic model to estimate the implicit marginal prices of 17 local public goods in a Paris suburban area on an original data set of some 8200 housing units. The results reveal a robust effect of local public school quality (measured both by the fraction of junior high school students that are at least 2 years behind grade level and the student/teacher ratio) on house prices. It is observed that housing owners' marginal willingness to pay for reducing commuting time is roughly similar for public transportation than for car transportation. Another noticeable result is the complete capitalization of local taxes at a discount rate of 3,5%. An illustration of the potential usefulness of the results for Cost-Benefit analysis is also provided.

*CSH (Delhi) and IDEP-GREQAM, 2, Aurangzeb Road, 11 0011 Delhi, India, nicolas.gravel@csh-delhi.com.

[†]THEMA, Université de Cergy-Pontoise, 33, Bd du Port, 95 011 Cergy-Pontoise, Cedex, France,
alexandra.michelangeli@eco.u-cergy.fr

[‡]IDEP-GREQAM and EHESS, Centre de la Vieille Charité, 2, rue de la Charité, 13 002 Marseille Cedex,
France trannoy@ehess.univ-mrs.fr

1 Introduction

It is well-known that if a good is traded in a competitive market, the social value of a ‘small’ additional quantity of the good is measured by its market price, if the initial distribution of wealth, which gives rise to the competitive equilibrium, is considered optimal. A problem that arises when one wants to apply this principle to the evaluation of ‘small’ public projects is that most goods supplied by such projects (such as quality of public schools, public parks, etc.) are not directly traded on competitive markets. Either for their intrinsic property (non-rivalry in consumption and non-excludability) or for exogenous political reasons, they belong to the category of public goods. How can the authority in charge of producing these goods obtain the relevant information about their social value ?

When public goods are *local*, the ‘*hedonic*’ or - more revealingly -*implicit* price theory popularized by Rosen (1974) provides an answer to that question. Recall that hedonic price theory views a housing as a bundle of utility-bearing characteristics, some of which being the public goods to which the occupation of the house give access. Accordingly, this theory interprets the price of a house as the market evaluation, by a *hedonic price function*, of the particular package of characteristics embodied in it. Although local public goods themselves are not traded on competitive markets, units of housing which give access to these local public goods are. Like for private goods, therefore, the increase in housing price brought about by a “small” increase in the quantity of a public good can be interpreted as the marginal social value of this public good and be used as such in cost-benefit analysis (see e.g. Scotchmer (1985; 1986) and Kanemoto (1988) for a complete discussion of the use of hedonic prices in cost-benefit analysis)¹.

¹The *local* character of the information conveyed by empirical estimates of a hedonic price function, to which we stick in the present paper, is worth emphasizing. Only under very specific assumptions (such as those considered

1
2
3
4 Empirical estimations of housing hedonic prices functions including local public goods have
5
6 been abundant in North America in the last thirty years (see Kiel and McClain (1996) or
7
8 Lynch and Rasmussen (2001) for example). They have been much more rare in Europe (see
9
10 however Cheshire and Sheppard (1995) and Ginsburgh and Waelbroeck (1998)) and this paper
11
12 is primarily intended as a contribution toward closing the huge gap that separates North America
13
14 from Europe in terms of empirical knowledge of the value attached by citizens to specific local
15
16 public goods. In our view, improving knowledge on this matter in Europe is a necessary step
17
18 in understanding the differences between Europe and North America in terms of public good
19
20 provision and financing.
21
22
23
24

25 A particular area where this comparison is likely to be instructive is *education*. Many hedonic
26
27 studies performed in the United States² have found a *significant* negative relationship between
28
29 the housing price and the pupil/teacher ratio at local public schools. This ratio is interpreted
30
31 as an indicator of the “objective” input devoted into the children’s human capital production
32
33 process by the public authorities. However, it is certainly not the only input of the human capital
34
35 production function. Another input, which has been the object of a an important theoretical
36
37 and empirical literature³ is the quality of the ‘peers’ with whom the pupil interacts. However
38
39 the American public school system makes the observed negative relationship between housing
40
41 prices and pupil/teacher ratios somewhat difficult to interpret. This difficulty arises because,
42
43 in the United States, public schools are managed and partially or wholly financed at the local
44
45 (county or state) level. As a result, the across-county differences in public subsidies received
46
47

in Bartik (1987)) can an estimation of the hedonic price function provide global information on preferences and
48
49 technology. A thorough discussion of these issues is provided in Ekeland *et al* (2004).
50
51

52
53 ²See for instance Bogart and Cromwell (1997) and Black (1999).

54
55 ³See e.g. Arnott and Rowse (1987), Hanuscheck (1986).
56
57
58
59
60

1
2
3
4 by schools tend to be heavily correlated with the sociological characteristics of the counties.
5
6 For this reason an observed relationship between housing prices and pupil/teacher ratios in the
7
8 United States could in part reflect a concern for avoiding bad peers rather than a preference for
9
10 smaller class sizes *per se*. Ideally, one would like to disentangle the household's valuation of the
11
12 relative impact of the two inputs on human capital accumulation.
13
14

15
16 Our data set and the institutional framework of the public school system in France enables
17
18 us to decompose these differing effects to some extent. The public school system is managed
19
20 by the central government which pursues an egalitarian aim. As a result, differences between
21
22 the public subsidies received by different schools are small and they tend to be slightly biased
23
24 in favor of the relatively poor cities. These institutional features of the French public school
25
26 system suggest that cross-cities variations in the pupil/teacher ratio are less likely to be related
27
28 to variations in the quality of the 'peer group' in France than in the U.S. As it happens, our
29
30 data contains a plausible indicator of the academic quality of the peers that a given pupil will
31
32 encounter when attending local public school and hence enable us to disentangle the peer group
33
34 effects from the input effect.
35
36
37
38

39
40 Another kind of local public good that is likely to be valued differently in Europe and in
41
42 the US is *public transportation*. In Paris outskirts, 50% of inhabitants go to work by car,
43
44 28% use public transportation and 12% use both systems.⁴ These figures are typically much
45
46 higher than in US metropolitan areas. As it turns out, very few empirical hedonic studies have
47
48 included variables that measure access to public or private transportation network. Given the
49
50 role devoted to transportation in standard urban theory (see e.g. Fujita 1999), this neglect is
51
52 somewhat surprising.
53

54
55 ⁴Source: INSEE census 1999.
56
57
58
59
60

1
2
3
4 We provide in this paper an estimation of a hedonic price function on an original data set of
5
6 some 8200 observations on individual dwelling prices collected from the 33 largest cities of Val
7
8 d'Oise (an administrative area that counts 1 million of inhabitants in the north-west of Paris)
9
10 over the 1985-1993 period. By contrast to many studies in the literature, we include a large
11
12 number (17) of public goods, among which are the quality of local public schools (measured
13
14 both by the fraction of junior high school students that are at least 2 years behind grade
15
16 level and the student/teacher ratio), geographical characteristics (distance from Roissy airport,
17
18 geographic elevation of the location, the fraction of the city's area devoted to recreational land,
19
20 etc.) and cultural/commercial infrastructure (number of historical buildings, playground fields,
21
22 retail stores, public entertainment centers, etc. relative to the number of inhabitants). Also
23
24 included are local tax rates on housing as well as measures of the commuting time (both by
25
26 public transportation and by car) during rush hour. We also have at our disposal information
27
28 on many housing-specific characteristics such as the size of the housing, the availability of a
29
30 balcony, an equipped kitchen, and the like.
31
32
33
34
35

36 The plan of the rest of the paper is as follows. In the next section, we sketch the theoretical
37
38 model. In the third section, we present our data set and the estimation method. The results
39
40 are discussed and interpreted in the fourth section. The fifth section uses our hedonic estimates
41
42 to examine an actual expenditure program designed by the French government to reduce school
43
44 delinquencies in a few cities covered by our sample and recall the conditions that enable one
45
46 to interpret partial derivatives of housing prices with respect to public goods characteristics as
47
48 marginal social values of the public goods. The sixth section concludes.
49
50
51
52
53
54
55
56
57
58
59
60

2 Theoretical model

The model described here is standard and is presented for the sake of completeness. Consider the problem of a household who chooses a quantity of a perfectly divisible private good (say money) and exactly one unit of housing. Alternative units of housing are assumed to be completely differentiated by their content in K implicit (but observable) characteristics. As in Rosen (1974), a unit of housing can thus be thought of as a vector in the non-negative orthant of the K -dimensional Euclidean space. It is further assumed that the number and variety of different cities and housing units is sufficiently large for the choice among city-specific and housing-specific characteristics to be assumed continuous ‘for all practical purposes’ (Rosen (1974)). This assumption is rather stringent in the context of location choice and should, at best, be seen as an approximation. The interpretation given to the empirical model estimated in this paper would *not* hold if the choice among alternative housing units was assumed to be discrete.

Let \mathbf{X} denote the (closed and convex) set of all conceivable packages of the K characteristics. The household’s preferences for the various combinations of private goods and housing characteristics are represented by a twice continuously differentiable strongly quasi-concave and weakly increasingly monotonic utility function $U : \mathbf{X} \rightarrow \mathbb{R}_+$ with image u . Every unit of housing with combination of characteristics $\mathbf{c} \in \mathbb{R}_+^K$ has a market price which can be thought of as the image of \mathbf{c} under a function $h : \mathbb{R}_+^K \rightarrow \mathbb{R}_+$. The function h is commonly referred to as a *hedonic price function*. It assigns a price to every unit of housing as a function of its characteristics. We assume that h is strictly monotonically increasing and differentiable with respect to every characteristic. The household is assumed to act on the premises that h is given and independent from its location and housing-specific package choice.⁵

⁵Questions related to the existence and interpretation of $h(\cdot)$ in a (spatial) general equilibrium with production

Taking the private good as the numéraire, and assuming that the household is initially endowed with y units of the private good, the decision problem faced by the household is:

$$\max_{(\mathbf{c}, x)} U(\mathbf{c}, x)$$

subject to

$$x + h(\mathbf{c}) \leq y \text{ and } (\mathbf{c}, x) \in \mathbf{X} \quad (1)$$

where $x \in \mathbb{R}_+$ denote the quantity of private good consumed by the household. Assuming that $\mathbf{X} \cap \{(\mathbf{c}, x) \in \mathbb{R}_+^{K+1} : x + h(\mathbf{c}) \leq y\}$ has a non-empty interior in \mathbb{R}_+^{K+1} and given the properties of h and \mathbf{X} , it is clear that this program has a solution. A solution (\mathbf{c}^*, x^*) satisfies the first order conditions

$$\frac{\frac{\partial U(\mathbf{c}^*, x^*)}{\partial c_k}}{\frac{\partial U(\mathbf{c}^*, x^*)}{\partial x}} = \frac{\partial h(\mathbf{c}^*)}{\partial c_k} \quad (2)$$

for every characteristic k chosen in strictly positive quantity in the interior of \mathbf{X} . As usual, the left hand side of this equation is the marginal rate of substitution between the k^{th} characteristic and the private good. It gives the maximal quantity of private good that the household is willing to give up in order to have access to an additional (arbitrarily small) amount of the k^{th} characteristic. It gives the household's *marginal willingness to pay* for the k^{th} characteristic which, at the households' optimal choice, is equal to the *hedonic price* $\frac{\partial h(\mathbf{c}^*)}{\partial c_k}$ of this k^{th} characteristic.

3 Empirical implementation of the model

Since theory offers no guidance with respect to the form of the function h it is important to allow for some flexibility in the choice of the empirical functional form (see e.g. Cropper et al. (1988) are beyond the scope of this paper and are not addressed. The reader may consult Mas-Colell (1975) and Ellikson (1979).

or Rasmussen and Zuehlke (1990) for further discussion on the issue). We do so by specifying a Box-Cox (1964) transformation of the dependant variable.⁶ The empirical model we estimate is therefore, for every observation $j = 1, \dots, N$,

$$p_j(\lambda) = \sum_{k=1}^K \beta_k c_{kj} + \varepsilon_j \quad (3)$$

with

$$\begin{aligned} p_j(\lambda) &= \frac{p_j^\lambda - 1}{\lambda} \text{ if } \lambda \neq 0 \\ &= \ln p_j \text{ otherwise} \end{aligned}$$

where

p_j denotes the price of the unit of housing j ,

c_{kj} denotes the quantity of the k th characteristics possessed by the j th housing (with the convention that $c_{1j} = c_{1i} = 1$ for all $i, j = 1, \dots, N$), and

ε_j is a random term assumed to be identically, normally and independently distributed across observations with mean 0 and variance $\sigma_i^2 = \sigma_j^2 = \sigma^2$ for all i, j .

We shall later on refer to $p_j(\lambda)$ as to the *transformed price*.

The empirical function (3) enables one to calculate easily the first and second derivatives of the price with respect to the various characteristics. From (3), the first partial derivative of the housing price with respect to the k th characteristic in observation j is given by

$$\frac{\partial p_j}{\partial c_k} = \beta_k p_j^{1-\lambda} \quad (4)$$

which implies that the k th characteristic is a positive amenity if β_k is positive. The second partial derivative is given by

⁶See however Dickie, Delorme and Humphreys (1997) for statistical evidence that flexibility of Box-Cox transformations of the dependant variable in hedonic analysis may not be as large as one would like.

$$\frac{\partial^2 p_j}{\partial c_k^2} = (1 - \lambda) \beta_k^2 p_j^{1-2\lambda} \quad (5)$$

which implies that as long as λ is smaller than 1, the hedonic function is *convex* with respect to each characteristic, whatever the sign of β_k .

We estimate (3) by maximum likelihood.⁷ As shown by Dagenais and Dufour (1991) for general non-linear models and Spitzer (1984) for Box-Cox ones, hypothesis-testing by mean of standard Wald criteria (Student tests) or Lagrange multiplier techniques is not invariant to measurement units. Likelihood ratio tests do not suffer from this problem. On the other hand likelihood ratio tests do not lead easily to confidence intervals. We therefore present significance tests based on the likelihood principle and 95% confidence interval based on the Student distribution. The later requires a correct computation of the variance covariance matrix of the parameter estimates. In order to do that, we resort to a double length artificial regression (see e.g. Davidson and McKinnon (1993) Chapter 14 pp.492-499 for a thorough explanation of this method).

3.1 Data

The estimation of (3) requires micro data on housing prices, housing specific characteristics and amenity characteristics. The relative scarcity of reliable housing data sources in France pushed us to build up our own data set. We limit the study to the sales housing market (rental market is not considered) and to the administrative area of Val d'Oise in the northern part of Paris greater metropolitan area, west of Roissy international airport (see figure 1 in Appendix). In order to obtain reliable information on local public goods we further restrict ourselves to the 33

⁷Thorough explanations of estimation method can be found in Hyde (1999).

1
2
3
4 cities of the Val d'Oise that had at least 10000 inhabitants in the 1990 national census.
5

6 This limits the variability in the public goods characteristics. For this reason, we spread the
7 collection of data on individual housing prices in each of these 33 cities on a 9 years period (more
8 precisely 1985-1993). For each city and for every year, data on local public goods, measured
9 at the city level, were obtained from the relevant local public authorities. Data on housing
10 prices were collected from adds taken from free advertising local newspapers. These adds record
11 information on individual prices, the city where the housing is built, as well as on many housing-
12 specific characteristics (e.g. the number of rooms, the presence of a parking lot, an equipped
13 kitchen, etc.). Overall, 8192 observations were collected, allocated between the 33 cities and the
14 9 years according to the demographic weight of each city in the area.
15
16
17
18
19
20
21
22
23
24
25
26

27 There are at least three criticisms that one could make to our data set construction.
28

29 First, the spreading of the observations over 9 years raises the question of the intertempo-
30 ral stability of the hedonic price function h . We have addressed this issue by introducing time
31 dummies in the list of regressors. The spreading of observations over time raises also some inter-
32 pretative questions with respect to the relationship between housing's price at some period and
33 the characteristic of the housing at that and subsequent periods. Clearly, the K characteristics
34 of a housing should be distinguished by the time and, if necessary, the state of the world in
35 which they are made available. When buying a dwelling, a household cares about the package
36 of hedonic characteristics provided by the dwelling during the year of purchase but, also, during
37 all subsequent years of existence of the dwelling. Yet, in the empirical specification (3) of the
38 hedonic price function presented above, we explain the price of a particular housing at some year
39 only by the value taken by the considered characteristics at that same year. This way of doing
40 would be adequate if households purchasers were either holding stationary expectations about
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4 the future quantities of characteristics or holding rational expectations under the additional
5
6 assumption that housing characteristics are random walks.
7

8
9 Second, one must note that the prices recorded in the data base are advertised - or *supply* -
10
11 prices. Yet these advertised prices may behave differently from the housing prices at which units
12
13 of housing were actually traded. Using advertised - rather than transaction - prices would not
14
15 bias the estimation if the discrepancies between advertized and actual price were independent
16
17 from the characteristics of the dwelling. Yet, we have no way to empirically verify whether this
18
19 independence holds. Cheshire and Sheppard (1995) also use supply prices in their hedonic study.
20
21 They send to the advertisers of their sample a questionnaire three months after the collection
22
23 of the data to obtain additional information on the actual price at which the dwelling units
24
25 were sold (if they were). They report a rate of response of some 40% and, for the houses that
26
27 happened to be sold during the three months period, an average transaction price that is within a
28
29 1% interval of the average advertized price. Although the housing market considered in Cheshire
30
31 and Sheppard is somewhat different from that considered here, their results suggest at least that,
32
33 if it exists at all, the bias associated with the use of advertized price is not excessive.⁸
34
35
36
37
38

39 Third, the city level at which all amenities are measured may be considered inappropriate.
40
41 As discussed at length in the literature, it would be preferable to measure public good and
42
43 neighborhood variables at the finest level of observability. Unfortunately, our data set does not
44
45 allow for performing an analysis at a smaller level than the city one. Information on housing
46
47 units does not typically mention the neighborhood in which the unit is built. Moreover, many
48
49

50 ⁸It should also be noticed that advertized prices have one advantage over transaction prices reported to notaries:
51
52 They are not subject to such understatements as reported transaction prices can be. In France, understatement
53
54 of transaction prices reported to notaries is common as they enable the parties to reduce their tax payments (in
55
56 France, housing purchase is taxed at a rate of some 8%).
57
58
59
60

public amenities variables (e.g. tax rates) are only available at the city level.⁹

3.2 Variables

The list, description and definition of the 13 dwelling-specific variables and the 17 city specific amenity variables is given in Table 1 in Appendix. Table 2 provides descriptive statistics for the price and variables. We complete this description with a few additional comments on some of the public goods variables.

<Insert Table 2 here>

3.2.1 Education variables

As mentioned in introduction, we use two variables to measure the quality of local public schools. The variable *Peer* is defined as the fraction of the total number of children registered in the three last years of junior high school who are at *least two years* behind their normal grade level (as determined by their birth rate). Assuming (plausibly given the uniform norms implemented by the French ministry of education) that the pass/failure policy of local school authorities does not exhibit systematic cross-city variations, this indicator measures the fraction of ‘poorly performing’ peers that a given child will interact with on a daily basis in a local public junior high school. It is an institutional particularity of the public school french system which motivates

⁹It should moreover be noticed that, in France, the average size of the city is much smaller than in the US (the average city of our sample is only 7,4 Km²) For this reason, one may expect the inaccuracy of measuring amenities at the city level rather than at the neighborhood one to be less severe in France than there would be in the US.

1
2
3
4 our choice of the second year of the junior high school as the benchmark year to calculate the
5
6 fraction of poorly performing peers. As explained by Cousin (1996; p. 60) the second year of
7
8 junior high school is typically perceived to be the first year where failure is recognized to be
9
10 a good method for sending to the pupil (or to the parents) a signal that can help in future
11
12 orientation decisions (choosing a more applied school curriculum for instance). Hence until the
13
14 first year of junior high school, parents have the right to object to a possible proposal of failure of
15
16 their child made by the school authorities at the end of the year. Starting from the second year
17
18 of junior high school, parents lose this opportunity. Interestingly enough, in other regressions
19
20 not included in this present version, we have considered an alternative specification where the
21
22 quality of peers is measured by the number of children registered in the first year who are at
23
24 least two years backward. It turns out that the estimated coefficient of this second indicator
25
26 of peer group effect (which exhibits only a modest correlation of 0.23 with the variable *Peer*)
27
28 presents the wrong sign. It appears, therefore, that it is not the appropriate variable to measure
29
30 the quality of the peers with whom the pupil interacts.
31
32
33
34
35

36
37 The second variable is the standard *Student/teacher* ratio calculated, for each city and
38
39 year, on all public junior high-schools to which city resident are assigned by the public school
40
41 zoning system. This variable is obviously a good proxy for the physical input of the human
42
43 capital production function. One may notice on Table 2 that this variable exhibits very little
44
45 variation across cities and years due to the egalitarian norms implemented by the french central
46
47 authorities. The pupil/teacher ratios in junior high schools range from 21.9 to 27.1, with more
48
49 than 85% of the observations lying between 24 and 26.5. It should be noted that *Student/teacher*
50
51 is (slightly) negatively correlated with *Peer* (around 0.25) as well as with the variable that
52
53 measure poverty (0.41) in the city (see below). This suggests that the national public school
54
55
56
57
58
59
60

1
2
3
4 authorities allocate inputs across public schools in a way which partially attempt to compensate
5
6 the unequal distribution of sociological characteristics across cities.(see also Trancart (1998; p.
7
8 49) for more evidence on this).
9

10 11 12 **3.2.2 Accessibility** 13

14
15 We consider three variables that aim at capturing the accessibility of the city in which the
16
17 dwelling is located. Two variables, *Ptransport* and *Ctransport*, measure the time (in minutes)
18
19 required to commute from each of the 33 cities to Paris center at morning rush hour using,
20
21 respectively, public transportation and car transportation. Both variables are computed using
22
23 information available in 1996.¹⁰
24
25

26
27 Both *Ptransport* and *Ctransport* are intended to measure the time required to commute
28
29 from home to work. This rests on the “monocentric” assumption that most inhabitants of Val
30
31 d’Oise work in the center of Paris. Although this assumption is not strictly true, it is worth
32
33 keeping in mind that 40% of the jobs available in the Paris greater metropolitan area are located
34

35
36 ¹⁰Commuting time by public transportation is calculated from the various networks of public transportation
37
38 of the greater Paris metropolitan area (bus, suburban train, RER, and metro) using the official schedule of the
39
40 public transportation companies (essentially the RATP and the SNCF) for the morning rush hour (7:00-9:00).
41
42 This commuting time is the shortest that can be achieved when considering all possible combinations of itineraries.
43
44 It includes the average time taken to commute (by car if necessary) from the various point of the city where the
45
46 housing is built to the nearest access to the public transport network (train or RER station or bus depot) and
47
48 the waiting time if any. Destination of commuting is assumed to be the subway and RER station of Chatelet-les
49
50 Halles in the center of Paris.

51
52 Commuting time by car results from simulations performed on the road network of the Paris greater metropoli-
53
54 tan area at morning rush hour. Times are computed under the assumption that the driver takes the fastest route
55
56 to connect the center of the city where he or she lives to Chatelet train station. It also includes the time required
57
58 to park the car.
59
60

1
2
3
4 in the inner Paris, and that 22% of the inhabitants of Val d'Oise who work do so in the center
5
6 of Paris. It should also be noticed that, for historical reasons, the transportation network in
7
8 France (both public and private) is concentrically organized around the city center of Paris.
9
10 Many people who commute between two points of the Paris greater metropolitan area must
11
12 make an interconnection in the city center of Paris. For this reason the commuting time from
13
14 home to the city center of Paris does capture a significant part of the commuting time of a much
15
16 larger portion of the Val d'Oise workers than 22%.
17
18

19
20 One could of course question the use of *two* distinct variables to capture what is often
21
22 perceived as a *single* phenomenon: the time taken to commute from home to work. Such a
23
24 questioning is legitimate since, in each of the 33 cities covered in our sample, commuting time by
25
26 public transportation is *smaller* than commuting time by car. If the time spent in commuting
27
28 by car and the time spent in commuting by public transportation were perfect substitutes,
29
30 commuting time by car would not be valued at all by the housing market. Pushed at the limit,
31
32 if the two commuting times were perfect substitutes, one would not observe any inhabitant of the
33
34 Val d'Oise on the road network at the morning rush hours! As a matter of facts, the proportion
35
36 of pure car users among the commuters from the outer ring of the metropolitan area of Paris
37
38 (to which the Val d'Oise belongs) to Paris is only 19%¹¹. Hence 81% of these commuters use at
39
40 least once the public transportation system on some segment of the trip. Nonetheless, the fact
41
42 that a significant portion of commuters do use the car despite the time difference suggest that
43
44 the two transportation times are not perfect substitute. For this reason, we have chosen to keep
45
46 them both in the regression. Keeping constant commuting time by public transportation, one

47
48
49
50
51
52 ¹¹The number comes from “*Enquête globale transports*”, Syndicat des Transports Parisiens, 1997. This figure
53
54 is different from those presented in the introduction which concern all commuters and not only those ones who
55
56 from the suburbs commute to Paris.
57
58
59
60

1
2
3
4 could therefore expect *a priori* a positive impact of a marginal reduction of commuting time by
5
6 car on dwelling prices.
7

8
9 Although commuting from home to work is an important component of the individuals'
10
11 daily transportation activity, it is not the only one. People also commute to go shopping, to go
12
13 in vacation, to visit friends and relatives, etc. Not all of these commuting are oriented toward
14
15 the city center of Paris. To account for other transportation facilities offered by the dwelling
16
17 localization, we also use as a regressor the distance between the center of the city in which the
18
19 housing is built and the nearest (in kilometer) freeway entrance (*ACmotorway*). We interpret
20
21 this variable as a proxy for the accessibility of the dwelling in terms of overall road transportation.
22
23 It might be thought that the proximity of a freeway, albeit convenient in terms of transportation
24
25 facilities, can also be a source of pollution and noise. To account for this, we also introduce
26
27 among the regressors the number of kilometers of highway that cross the area of the city in
28
29 which the housing is built relative to the size of the city (*Rnuisance*). Hence the derivative of
30
31 the housing price with respect to *ACmotorway* measures the marginal willingness to pay of the
32
33 dwelling's owner for improving access to the freeway system, *given the density of this highway*
34
35 *system in the city where the dwelling is located.*
36
37
38
39
40
41
42

43 **3.2.3 Environmental variables**

44
45 In addition to *Rnuisance* which would fit naturally in this category, we have introduced the
46
47 physical distance between the center of the city and Roissy's international airport which bounds
48
49 the Val d'Oise on the east side. This variable (*DistRoissy*) captures the (noise) nuisance
50
51 associated with the geographic proximity of the airport.
52
53

54
55 Also considered are three variables that are intended to capture the aesthetic characteristics
56
57
58
59
60

1
2
3
4 of the site on which the dwelling is located. One of this variable (*Scenic*) measures the length
5
6 of scenic roads (expressed in meters relative to the area of the city) as recorded on a local
7
8 Michelin touristic map (under the label “picturesque stretch of road”).¹² We also have a variable
9
10 (*Elevation*) that is defined by the difference between the highest and the lowest point of the
11
12 city relative to the city’s (horizontal) area. Paris’ region is rather flat and, for this reason,
13
14 hills are much appreciated by residents. Finally, the last environmental variable (*Green*) is the
15
16 fraction of the city land opened to recreational activities (that is, free from agriculture, road,
17
18 and building).

19
20
21
22
23 The variable *Monuments* on the other hand, which measures, relative to the city’s area, the
24
25 number of historical buildings belonging to the national heritage, is intended to be a proxy for
26
27 some aesthetic unmeasured “charm” of the city. Finally, the variable *Shopping*, defined as the
28
29 number of detailed shops per 10000 inhabitants, captures the access to commercial facilities.
30
31

32 33 **3.2.4 Public goods and Taxes**

34
35
36 Two variables gathered under this heading aim at capturing proximity of the dwelling to various
37
38 intrinsically valuable public equipment (*Auditoria*, *Playgrounds*) which are mainly financed by
39
40 local budgets.
41

42
43 High taxes are the usual counterpart of a generous public good provision even though local
44
45 taxes are less tightly connected to local public good provision in France than they are in the
46
47 United States. There are two local taxes paid by households in France: A tax on real estate (*taxe*
48
49 *sur le foncier bâti*) (*REtax*) paid only by the owner of the housing and a so-called dwelling tax
50
51 (*taxe d’habitation*) (*Dtax*) paid by the household who lives in the dwelling (be it as landlord or as
52
53

54
55
56
57
58
59
60

¹²The map used is the 1998 edition of the Michelin map no.101 (outskirt of Paris: 1cm = 530 metres).

1
2
3
4 tenant).¹³ Each of these two taxes is collected by applying a tax rate, chosen by the local public
5
6 administration, to a dwelling-specific *administrative tax base* that bears no clear relationship with
7
8 the dwelling's market value.¹⁴ Since we do not observe tax liabilities, we proceed by regressing
9
10 housing on the two tax rates (along with the other housing characteristics). Although not
11
12 completely pure from a theoretical point of view, this procedure enables us nonetheless to account
13
14 to some extent for the capitalization of the taxes in the housing value. Furthermore our knowledge
15
16 of the *sample average* administrative tax base provides an indirect way of testing the degree of
17
18 tax capitalization. More specifically, our procedure enable us to check if the estimated hedonic
19
20 price of either tax rate corresponds to a capitalization of the future taxes liabilities brought
21
22 about by a marginal increase in the tax rates *evaluated at average value of the administrative*
23
24 *tax base*. Assuming that a purchaser of a unit of housing expects a marginal increases in the
25
26 current tax rate to remain in effect for ever, this procedure enables us in effect to infer the
27
28 *implicit discount rate* used by the household to calculate the present value of its future tax
29
30 liabilities. This 'revealed' discount rate can then be compared with the discount rate used in the
31
32 literature to test explicitly for tax capitalization.
33
34
35
36
37
38
39

40 **3.2.5 Sociological and neighborhood variables**

41
42
43 The variable *Poverty* is defined as the fraction of the households living in the city who are
44
45 exempt from the (national) income tax. This variable is interpreted as a proxy for factors that
46
47 enter into the production of several public goods supplied by a city and which may be correlated
48
49 with some of the public goods. The problem with an empirical specification such as (3) below
50
51 is that it neglects many public goods by putting them in the error term ε_j . Yet these omitted
52
53

54 ¹³ A household who owns the housing in which it lives pays both taxes.

55 ¹⁴ See Acosta and Renard (1993, p. 57 and 127) for more details.
56
57
58
59
60

1
2
3
4 characteristics are likely to be correlated with the amenities integrated in the empirical analysis.
5
6 The reason for this is that many local public goods of a given city (observed and unobserved)
7
8 are *produced* by a set of *common* production factors. An example of factors that enter jointly
9
10 in the production of several public goods is the distribution of sociological attributes (poverty
11
12 rate, average income, average level of education, etc.) within the population of a particular city.
13
14 Typically, one would expect cities with favorable distribution of sociological attributes to exhibit
15
16 better performance in terms of public safety, school success, quality of the neighborhood, etc.
17
18 than cities with less favorable distributions of these attributes. The fraction of the households
19
20 who are free from income tax liabilities is therefore interpreted as summary statistics for the
21
22 distribution of sociological traits.
23
24
25
26

27 We also test a crime variable but it turned out to have no significant impact on housing
28
29 prices. The weakness of the influence of crime on housing price is common in many hedonic
30
31 studies (see for instance Lynch and Rasmussen (2001)). It appears therefore that city is not the
32
33 appropriate level of measurement of criminal acts.
34
35
36
37

38 **3.3 Results**

39
40 The results obtained from estimating (3) with the independent variables of table 1 are presented
41
42 in Table 3.
43
44
45

46 <Insert table 3 here>
47
48
49

50 The best functional form for the hedonic price function is obtained for $\lambda = -0.1287$. As
51
52 indicated by the value of the likelihood ratio test, this functional form is significantly different
53
54 from the linear ($\lambda = 1$) or the log-linear ($\lambda = 0$) form. In accordance with the prediction of the
55
56 theoretical urban hedonic literature (see e.g. Anderson (1985) and Sheppard (1999)), it implies
57
58
59
60

1
2
3
4 an overall *convexity* of the hedonic price function with respect to the housing characteristics (in
5
6 particular, marginal willingness to pay for a given characteristic is increasing with respect to
7
8 the quantity of this characteristic).
9

10
11 As can be noticed, all housing characteristics behave in an *a priori* predictable way.
12

13
14 Focusing on public amenities variables, we first notice that, on these 17 variables, 16 are
15
16 significant at the 1% confidence level and 1 at the 5% (student/teacher ratio). All in all, the 25
17
18 variables used in our model account for 82% of the variance of the transformed housing price.
19

20
21 Table 4 gives the empirical estimates of hedonic prices for the urban amenities.¹⁵ They
22
23 correspond to the partial derivative of the hedonic price function in the case of continuous
24
25 variables, and to the discrete price difference in the case of discrete variables at the average
26
27 housing of the sample. Table 4 also gives, for all variables expressed in continuous units, the
28
29 absolute value of the “hedonic elasticity” of the amenity measured at the average housing (the
30
31 percentage variation in housing price brought about by a one percent variation in the amenity).
32
33

34
35 <Insert table 4 here>
36
37

38
39 For school variables, one notices that both are significant. The estimated marginal willingness
40
41 to pay for reducing by one point the fraction of poorly performing peers at school is 255 € (or
42
43 1417 € *per* point of standard deviation). Reducing class size by one pupil is valued 854 € by
44
45 the owner of the average housing of our sample (or 785 € *per* point of standard deviation) .
46
47 Summing these two effects, we obtain that the owner of the average housing is willing to pay
48
49 some 2200 € for reducing by one point of standard deviation the two indicators of school quality
50
51 considered herein. This should be compared with the marginal willingness to pay of 3948 \$
52
53 for a 1 point of standard deviation amelioration in test score at primary schools obtained by
54
55

56
57 ¹⁵Hedonic prices for private characteristics can be provided upon request.
58

1
2
3
4 Black (1999) in wealthy suburbs of Boston. We should mention also that, when interpreted in
5
6 a human capital perspective, these figures suggest that the impact of poorly performing peers
7
8 and/or student/teacher ratio on the (future) human capital of the child is modest. Take for
9
10 instance the 1417 € that the owner of the average household is willing to pay for reducing
11
12 by one point of standard deviation the fraction of poorly performing peers that its child will
13
14 encounter at public high schools. Assuming that this amount corresponds to the actualization
15
16 at a discount rate of 3.5% of future earning losses brought about by such an exposure to “bad
17
18 peers” and that the active life starts at 25 and ends at 65, such a hedonic price is consistent
19
20 with a yearly earning loss of... 65.3 €.
21
22
23
24

25 Transportation variables provide interesting results. Reducing either car or public trans-
26
27 portation time by one minute increases housing price. The value of reducing by one minute the
28
29 time taken to reach the city center of Paris is higher for public transportation than car (345
30
31 € by public transportation, 276 € by car) but the difference is not statistically significant. An
32
33 interesting exercise is to estimate the value of an elementary unit of time revealed by the hedonic
34
35 price of $P_{transport}$. Assuming that an average working individual will commute 230 days per
36
37 year forever, and using a discount rate of 3.5%, the hedonic price of 345 € associated with a one
38
39 minute reduction in commuting time is consistent with a value of the minute of some 5 cents (3
40
41 € for an hour). This figure, which is about half the net French minimum wage rate, suggests
42
43 either that the discount rate used is too low or that individuals tend to consider that commut-
44
45 ing time has less disutility than the time spent to work. The convexity of the hedonic price
46
47 function entails that the marginal willingness to pay is decreasing at a decreasing rate, which
48
49 is consistent with the predictions of classical models of the monocentric city. If the generalized
50
51 transportation cost (pecuniary and time cost) is linear or concave with respect to the distance to
52
53
54
55
56
57
58
59
60

1
2
3
4 the central business district (CBD), then the equilibrium market rent curves are strictly convex
5
6 with respect to the distance to the CBD (see e.g. Fujita (1999 p. 57)). This interpretation
7
8 must of course be taken with a grain of salt since the convexity observed here concerns to the
9
10 commuting time, while the prediction of the theory is about the physical distance.
11
12

13
14 Another interesting result is the significant hedonic price of 857 euros attached to a one
15
16 kilometer reduction in the distance from the nearest freeway entrance (given the density of the
17
18 highway network in the city where the dwelling is built). The significant hedonic price of 1881
19
20 euros attached to a kilometer reduction in the density of this network (given the distance from
21
22 the nearest freeway entrance) is even more interesting. It reveals that the nuisance created by
23
24 highway (given access) is more important (in absolute value) than the benefit which results from
25
26 improving access (given nuisance).
27
28

29
30 Living one kilometer away from Roissy airport increases the value of the average housing by
31
32 some 275 euros.
33

34 The four environmental and geographical variables *Scenic*, *Elevation*, *Green*, and *Monuments*
35
36 are significant but their contribution to price seems rather modest.¹⁶
37
38

39 The hedonic price of adding one auditorium in the (virtual) city in which the average dwelling
40
41 is built (4105 euros, roughly 4 % of the price of the average housing) might look high at first
42
43 glance. It is difficult to believe that it is the representative dwelling purchaser's intrinsic prefer-
44
45 ence for music, theatres, etc. which accounts for a willingness to pay of 4105 euros just to live
46
47

48 ¹⁶For these variables, we compute the hedonic price associated with an increase of the numerator of the variable
49
50 equal to one unit (with the exception of *Elevation* for which we consider an increase of the numerator equal to
51
52 10 meters). So we have the hedonic price of one more kilometer of scenic roads in the (virtual) city in which the
53
54 average dwelling is built (or the hedonic price of one more hectare of green space or of an additional monument).
55
56 We use the same method of computation for the variables *Auditoria* and *Playgrounds*.
57
58
59
60

1
2
3
4 in a city which possesses one more show room than the average city. A possible explanation is
5
6 that the fact for a city to have or not an auditorium is a proxy for other unmeasured amenities.
7
8 This explanation finds some support in the fact that more than one half of the cities covered by
9
10 our sample (precisely, 19 out of 33) do not have any auditorium.
11
12

13
14 An interesting result is the strong capitalization effect of local tax rates. For increasing by
15
16 one point the dwelling tax rate (resp. the real estate tax rate) leads to a reduction of 773 euros
17
18 (resp. 718 euros) in the value of the average housing unit. In terms of the earlier discussion,
19
20 if we apply the tax rates on a unit of housing of average *administrative* value, and under the
21
22 assumption that a one point increase in the tax rate is expected by the household to last forever,
23
24 our average estimate of the negative capitalization of 773 euros (resp. 718) reveals a discount rate
25
26 of 3.7% (resp. 3.2%). The difference between the two rates is not statistically significant. These
27
28 figures fall down a plausible confidence interval of the actual real interest rates on mortgage
29
30 loans observed for that period; In terms of Palmon and Smith's (1998) methodology, these
31
32 results indicate a *full capitalization of taxes* at a real discount rate of 3.5%. They suggest the
33
34 existence of an almost complete "Laffer effect". If tax authorities were to base their local tax
35
36 rate on the market (rather than administrative) value of the housing, then increasing tax rates
37
38 would have virtually no effect on the expected future government tax revenues.
39
40
41
42
43
44

45 **4 Policy implications of the results**

46
47
48 In this section, we show how, under specific assumptions, hedonic prices of public goods provide
49
50 exact measures of their social marginal values and we use our hedonic estimates to evaluate some
51
52 public programs aimed at reducing school failure in poor cities. We first recall the condition under
53
54 which the sum of hedonic prices for a public good taken over the inhabitants of a particular city
55
56
57
58

provides an exact measure of the social value attached by the population of the city for a small improvement in the available quantity of this public good.

Assume that there are H households who make the same decision as that of the representative household examined in section 2 (indexing by $i \in \{1, \dots, H\}$ their utility functions and consumption sets and denoting by \hat{y}_i the wealth of household i). All these households face the same hedonic price function $h(\cdot)$. Since every household's optimal choice of characteristics package depends upon wealth only (given $h(\cdot)$), we define household i 's indirect utility function $V_i : \mathbb{R}_+ \rightarrow \mathbb{R}_+$ with image v_i by

$$V_i(\hat{y}_i) = \max_{(\mathbf{c}, x)} U_i(\mathbf{c}, x)$$

subject to $x + h(\mathbf{c}) \leq \hat{y}_i$ and $(\mathbf{c}, x) \in \mathbf{X}$

Assume now that the distribution of incomes across households is considered optimal with respect to the social evaluation function $S : \mathbb{R}_+^H \rightarrow \mathbb{R}_+$ defined by

$$S(y_1, \dots, y_H) = W(V_1(y_1), \dots, V_N(y_H))$$

where $W : \mathbb{R}_+^H \rightarrow \mathbb{R}_+$ is a continuously differentiable and increasingly monotonic Bergson-Samuelson social welfare function. This assumption amounts to asserting that observed $(\hat{y}_1, \dots, \hat{y}_H)$ are (interior) solutions of the following program

$$\max_{y_1, \dots, y_H} S(y_1, \dots, y_H) \text{ subject to } \sum_{i=1}^H y_i \leq \sum_{i=1}^H \hat{y}_i \quad (\text{P})$$

and, therefore, satisfy first order conditions

$$\frac{\partial W(V_1(\hat{y}_1), \dots, V_N(\hat{y}_H))}{\partial v_i} \frac{\partial V_i(\hat{y}_i)}{\partial y_i} = \frac{\partial W(V_1(\hat{y}_1), \dots, V_N(\hat{y}_H))}{\partial v_l} \frac{\partial V_i(\hat{y}_l)}{\partial y_l} = \lambda$$

for every household i and l where λ is some real non-negative constant (the Lagrange-Kuhn-Tucker multiplier associated to the constraint in the program (P)).

1
2
3
4 Assume that we want to evaluate the social value of a “small” project consisting in an
5
6 increment of dc_k in the quantity of the amenity k in some city j . Letting H^j denoting the
7
8 number of households who optimally choose to locate in city j , the social value ΔW of such a
9
10 project at households’s initial optimal choice is approximated by

$$11 \quad \Delta W = \sum_{i=1}^{H^j} \frac{\partial W(V_1(\hat{y}_1), \dots, V_N(\hat{y}_N))}{\partial v_i} \frac{\partial U_i(\mathbf{c}_i^*, x_i^*)}{\partial c_k} dc_k$$

12
13 From the first order conditions of households maximization programs, this can be written as

$$14 \quad \Delta W = \sum_{i=1}^{H^j} \frac{\partial W(V_1(\hat{y}_1), \dots, V_N(\hat{y}_N))}{\partial v_i} \frac{\partial V_i(\hat{y}_i)}{\partial y_i} \frac{\partial h(\mathbf{c}_i^*, x_i^*)}{\partial c_k} dc_k$$

15
16
17
18
19
20
21
22
23
24
25
26
27 which, given the optimality of income distribution and ordinality of social welfare measurement,
28
29 amounts to

$$30 \quad \Delta W = \sum_{i=1}^{H^j} \frac{\partial h(\mathbf{c}_i^*, x_i^*)}{\partial c_k} dc_k$$

31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
In a continuous context with optimal distribution of incomes therefore, summing the implicit
marginal prices of local public goods produced by a “small” project over all occupied housings
built in the location where the project is implemented provides an exact measure of the so-
cial value of the project. It is worth emphasizing the strength of the condition that observed
households incomes are optimally distributed with respect to the same social welfare function
as that used to appraise the value of public projects. This condition amounts to using in project
evaluation the same ethics as that who considers the *actual* income distribution to be “just” (or
socially optimal). This particular ethic may not command widespread support.

<Insert table 5 about here>

Given this proviso, we can apply this formula and compute the social benefit that a reduction
of one unit in some local public good could bring about in the cities. We do this in table 5 for the

1
2
3
4 variable *Peer* in a few poor cities of Val d'Oise in which the French Ministry of the city affairs
5
6 has launched a large expenditure program. Column 3 in table 5, evaluates the sum of marginal
7
8 willingness to pay for a one point reduction in *peers* taken over all landlords of every concerned
9
10 city. These benefits, although significant, underestimate the total benefits that the inhabitants
11
12 of the city would obtain out of the policy since they take no account of households who do not
13
14 own their housing.¹⁷ These figures can be compared with the government capital spending in
15
16 these cities for local public schools that appear in column 4. It is of course difficult to appraise
17
18 these figures without further information on the technology used by the government to convert
19
20 public fund into reduction of behind grade levelness at school. However, and unless we assume
21
22 an extremely high rate of conversion of government money into reduction of school failure, we
23
24 must recognize that government spending is very modest in most of the cities with respect to our
25
26 estimation of the benefits aimed. Column 5 and 6 make the same kind of comparison in annual
27
28 terms using the discounted rate revealed by the capitalization of tax rate in our empirical model.
29
30 Here again, government spending seems modest relative to our estimation of the benefits.
31
32
33
34
35
36
37
38
39
40
41

5 Conclusion

42 This study reveals a few noticeable facts. In Paris metropolitan area, dwelling prices appear to
43
44 be sensitive to both public and car transportation. At a discount rate of 3.5%, the willingness
45
46 to pay of the owner of the average housing of our sample for reducing marginally her commuting
47
48 time to work is consistent with an hourly value of this owner's time of some 3 euros, a figure
49

50 ¹⁷On the other hand, it is worth recalling that housing prices used in this study are supply prices and not
51
52 transaction prices. It is also probably worth recalling that these figures are obtained from the sale (rather than
53
54 the renting) market. These two states of affairs suggest an overestimation of the marginal willingness to pay.
55
56
57
58
59
60

1
2
3
4 that is much lower than the value of the minimum wage for the reference years. The second
5
6 important results revealed by our study is the clear capitalization of local taxes. Furthermore,
7
8 our empirical results support the view that the quality of local public schools affects significantly
9
10 housing price. It appears that both objective inputs and peer group effects affects significantly
11
12 house price when control is made for other neighborhood variables such as the poverty rate.
13
14 The importance of the estimates of the social marginal value of avoidance of bad peer is worth
15
16 stressing. In an average city counting 25000 landlords, a policy leading to a reduction of one
17
18 percent in the number of children who fail at school has a social marginal value of some 6.375
19
20 million of euros.
21
22
23

24 Acknowledgements

25
26 We gratefully acknowledge the financial support from the “Direction Générale de l’équipement
27
28 du Val d’Oise” as well as from the program “Action concertée incitative Villes” of the Ministère
29
30 de l’enseignement supérieur et de la recherche. We thank also Stéphane Bujreau and Jean-
31
32 François Guillaume for their competent research assistance, André de Palma and Cedric Fontan
33
34 for providing us the data about transportation time costs and Richard Arnott and Nancy Wallace
35
36 for helpful comments and Fabrice Barthélémy for a thorough discussion about DLR.
37
38
39

40 References

- 41
42
43
44 Acosta, R. and Renard, V. (1993) “Urban Land and Property Markets in France”, UCL Press.
45
46
47 Anderson, J.E. (1985) “On testing the convexity of the hedonic price function”, *Journal of*
48
49 *Urban Economics*, **18**, p.334-337.
50
51
52
53 Arnott R. and Rowse, J. (1987) “Peer Group Effects and Educational Attainment”, *Journal of*
54
55 *Public Economics*, **32**, p.287-305.
56
57
58
59
60

- 1
2
3
4 Bartik, T.J. (1987) "The Estimation of Demand Parameters in Hedonic Prices Models", *Journal*
5
6 *of Political Economy*, **95**, p.81-88.
7
8
- 9 Black, S.E. (1999) "Do Better Schools Matter? Parental Valuation of Elementary Education",
10
11 *Quarterly Journal of Economics*, **114**, p.578-599.
12
13
- 14 Bogart, W.T. and B.A Cromwell (2000), "How much is a good school worth", *National Tax*
15
16 *Journal*, **47**, p.280-305.
17
18
- 19 Box, G.E.P. and Cox, D.R. (1964) "An Analysis of Transformations", *Journal of the Royal*
20
21 *Statistical Society*, ser. B, p. 211-252.
22
23
- 24 Cheshire, P. and Sheppard, S. (1995) "On the Price of Land and the Value of Amenities",
25
26 *Economica*, **62**, p. 247-267.
27
28
- 29 Cousin, O. (1996) "Construction et Evaluation de l'Effet Etablissement", *Revue Française de*
30
31 *Pédagogie*, **115**, p. 59-75.
32
33
- 34 Cropper, M.L., Deck, B.L. and McConnell, K.E. (1988) "On the Choice of Functionnal Form
35
36 for Hedonic Price Function", *Review of Economics and Statistics*, **70**, p. 668-675.
37
38
- 39 Dagenais, M.G. and Dufour, J.M. (1991) "Invariance, Nonlinear Models, and Asymptotic
40
41 Tests", *Econometrica*, **59**, p. 1601-1615.
42
43
- 44 Davidson, R. and McKinnon, J.G. (1993) "*Estimation and Inference in Econometrics*", New-
45
46 York, Oxford University Press.
47
48
- 49 Dickie, M., Delorme, J. R. and Humfrey, J. M. (1997) "Hedonic prices, good-specific effects
50
51 and functional form: Inferences from cross-section time series data", *Applied Economics*,
52
53 **29**, 239-249.
54
55
56
57
58
59
60

- 1
2
3
4 Ekeland, I., Heckman, J.J. and Nesheim, L. (2004) "Identification and Estimation of Hedonic
5
6 Models", *Journal of Political Economy*, **112**, p. 60-109.
7
8
- 9
10 Ellikson, B. (1979) "Competitive Equilibrium with Local Public Goods", *Journal of Economic*
11
12 *Theory*, **21**, p. 46-61.
13
14
- 15 Fujita M.(1999) "*Urban Economic Theory, Land Use and City Size*", Cambridge University
16
17 Press, Cambridge, paperback reprint.
18
19
- 20 Ginsburgh, V. and Waelbroeck, P. (1998) "The EC and Real Estate Rentes in Brussels",
21
22 *Regional Science and Urban Economics*, **28**, p. 497-511.
23
24
- 25 Hanushek, E.A. (1986) "The Economics of Schooling: Production and Efficiency in Public
26
27 Schools", *Journal of Economic Literature*, **24**, p. 1141-1177.
28
29
- 30 Hyde, S.K. (1999) "Likelihood Based Inference on the Box-Cox Family of Transformations:
31
32 SAS and Matlab Programs", *Technical Report*, Mathematical Sciences, Montana State
33
34 University.
35
36
- 37
38 Kanemoto, Y. (1988) "Hedonic Prices and the Benefit of Public Projects", *Econometrica*, **56**,
39
40 p.981-989.
41
42
- 43
44 Kiel, A.K and McClain, K.T. (1996) "House Price Recovery and Stigma after a Failed Siting",
45
46 *Applied Economics*, **28**, 1351-1358.
47
48
- 49 Lynch, A.K. and Rasmussen, D.W. (2001) "Measuring the Impact of Crime on House Prices",
50
51 *Applied Economics*, **33**, p.1981-1989.
52
53
- 54 Mas-Colell, A. (1975) "A Welfare Analysis of Equilibrium with Differentiated Commodities",
55
56 *Journal of Mathematical Economics*, **2**, p. 263-295.
57
58

- 1
2
3
4 Palmon, O. and Smith, B.A. (1998) "A New Approach for Identifying the Parameters of a Tax
5
6 Capitalization Model", *Journal of Urban Economics*, **44**, p. 299-316.
7
8
- 9
10 Rasmussen, D.W. and Zuehlke, T. W. (1990) "On the Choice of Functional Form for Hedonic
11
12 Price Functions", *Applied Economics*, **22**, p. 431-438.
13
14
- 15
16 Rosen, S. (1974) "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Com-
17
18 petition", *Journal of Political Economy*, **82**, p. 34-55.
19
- 20
21 Scotchmer, S. (1985) "Hedonic Prices and Cost/Benefit Analysis", *Journal of Economic Theory*,
22
23 **37**, p.55-75.
24
- 25
26 Scotchmer, S. (1986) "The Short Run and the Long Run Benefits of Environmental Improve-
27
28 ments", *Journal of Public Economics*, **30**, p.61-81.
29
- 30
31 Sheppard, S. (1999) "Hedonic Analysis of Housing Markets", in Cheshire, P. and Mills, E.,
32
33 eds., *Handbook of Regional and Urban Economics*, vol. 3. North-Holland, New York.
34
- 35
36 Spitzer, J. J. (1984) "Variance Estimates in Models with the Box-Cox Transformation: Impli-
37
38 cations for Estimation and Hypothesis Testing", *Review of Economics and Statistics*, **66**,
39
40 p. 645-652.
41
42
- 43
44 Trancart, D.(1998) "L'Evolution des Disparités entre Colléges Publics", *Revue Française de*
45
46 *Pédagogie*, **124**, p. 43-53.
47
48
49

50 **6 Appendix**

51
52
53

54 <Insert figure 1 about here>

55 <Insert table 1 about here>

56
57
58
59
60

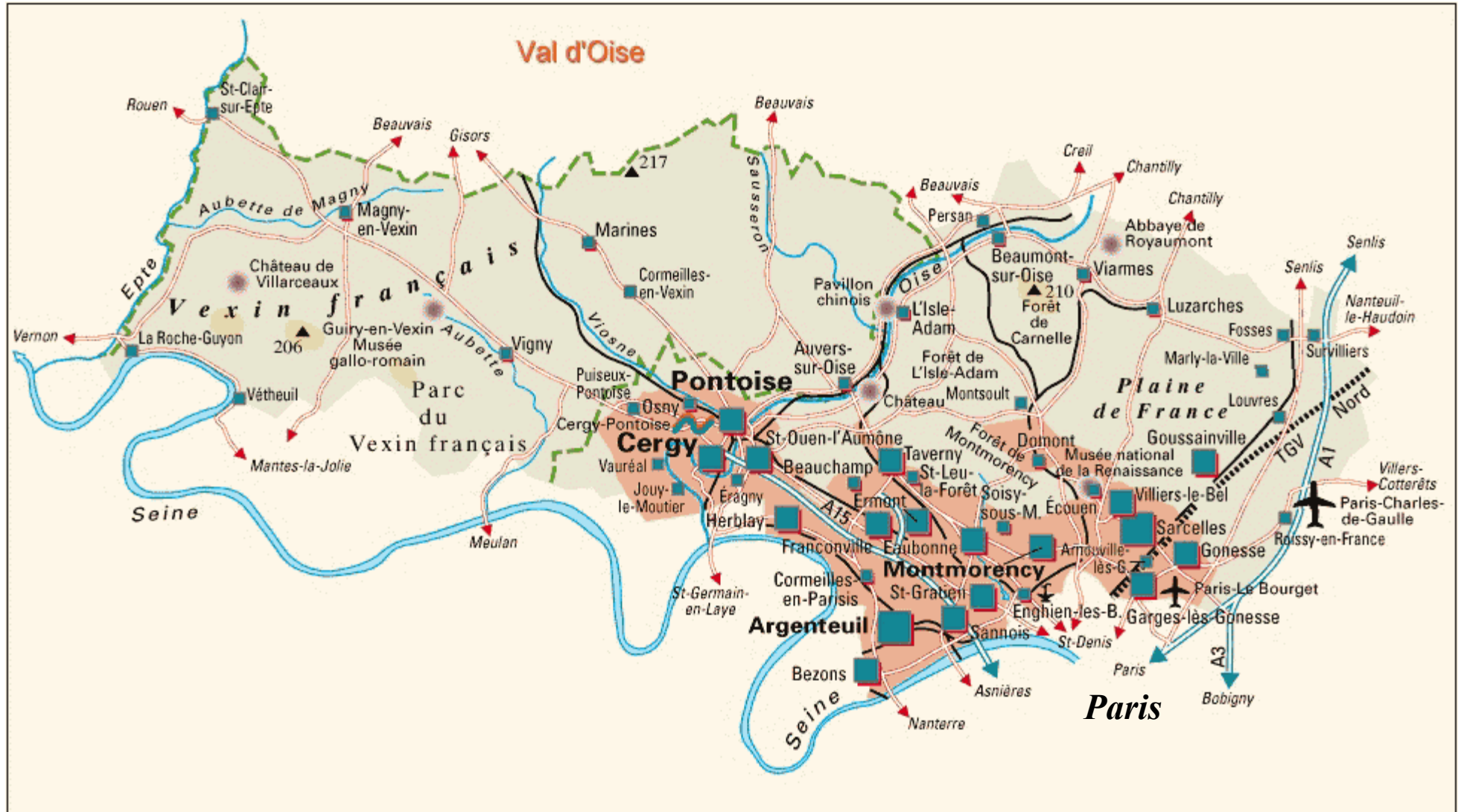


Figure 1: Map of Val d'Oise

Table 1: Variable Description

A) Private variables

Variable Name	Definition	Unit of measurement	Source
Price	price of the housing divided by a price index	continuous (euros)	free newspapers adds
Second room	whether or not the housing has a second room	dummy	free newspapers adds
Third room	whether or not the housing has a third room	dummy	free newspapers adds
Fourth room	whether or not the housing has a fourth room	dummy	free newspapers adds
Fifth room	whether or not the housing has a fifth room	dummy	free newspapers adds
Sixth room	whether or not the housing has a sixth room	dummy	free newspapers adds
Another room	number of rooms above 6	discrete	free newspapers adds
Balcony	whether or not the housing has a balcony	dummy	free newspapers adds
Kitchen	whether or not the housing has an equipped kitchen	dummy	free newspapers adds
Parking	whether or not the housing has a parking	dummy	free newspapers adds
House	whether or not the housing is a house or an apartment in a collective building	dummy	free newspapers adds
Basement	whether or not the housing has a basement	dummy	free newspapers adds
Garden	whether or not the housing has a garden	dummy	free newspapers adds
Garden size	size of the garden	continuous (m ²)	free newspapers adds

F) Education variables

Variable Name	Definition	Unit of measurement	Source
Peer	fraction of the high school pupils who are at least two years backward in the three last years of high school	percent (average over the public schools in the city)	Ministry of education
Pupils/teacher	average number of pupils per class in public high schools	percent (average over the public schools in the city)	Ministry of education

B) Accessibility

Variable Name	Definition	Unit of measurement	Source
Ptransport	time taken by public transportation to commute between the city center and the center of Paris in the morning rush hour	Minutes	I.A.U.R.I.F (96)
Ctransport	time taken to commute by car between the city and the center of Paris in the morning rush hour	Minutes	I.A.U.R.I.F (96)
ACmotorway	distance between the city center and the nearest freeway entrance	Km	computation by the authors

C) Environmental and geographic variables

Variable Name	Definition	Unit of measurement	Source
DistRoissy	distance between the city and Roissy airport	km	computation by the authors
Rnuisance	length of the highway network relative to the city territory	km/km squared	computation by the authors
Scenic	length of scenic roads relative to the area of the city	km/ km squared	Michelin's map, ed.1998, n.101
Elevation	difference between the highest and the lowest point in the city relative to the area of the city	m/m squared	computation by the authors
Green	hectares of the city land open to public as natural space relative to the area of the city	percent	Inventaire des terrains ouverts au public, Val d'Oise I.A.U.R.I.F 1990
Monuments	Number of historical buildings per km squared	continous	Inventaire Communal INSEE 1998
Shopping	number of salaried workers in retail stores per 10000 inhabitants	continous	Unemployment Insurance office of the Paris Metropolitan Area

E) Public goods and taxes

Variable Name	Definition	Unit of measurement	Source
Auditoria	number of auditoria per 10000 inhabitants	continous	National census (1981 and 1990)
Playgrounds	number of playgrounds per 10000 inhabitants	continous	National census (1981 and 1990)
REtax	rate of the tax on real estate	percent of the administrative value of the housing	Tax authorities
Dtax	rate of the dwelling tax	percent of the administrative value of the housing	Tax authorities

G) Sociological and neighborhood variables

Variable Name	Definition	Unit of measurement	Source
Poverty	fraction of households who do not pay income taxes	percent	Tax authorities

Table 2: Summary statistics for the variables

Variable	Mean	Standard deviation	Minimum	Maximum
House's price	112380.40	64795.62	12195.92	666202.20
Second room	0.964	0.185	0	1
Third room	0.885	0.318	0	1
Fourth room	0.682	0.465	0	1
Fifth room	0.396	0.489	0	1
Sixth room	0.163	0.369	0	1
Another room	0.084	0.412	0	6
Equipped kitchen	0.337	0.472	0	1
Parking	0.656	0.474	0	1
Balcony	0.274	0.446	0	1
House	0.555	0.496	0	1
Basement	0.580	0.493	0	1
Garden	0.384	0.486	0	1
Garden size	186.49	320.79	0	5700
Peer	17.99	5.55	6.37	36.47
Student/teacher	25.15	0.909	21.94	27.11
Ptransport	45.86	10.56	31	76
Ctransport	96.42	9.76	79	124
Acmotorway	3.430	2.78	0.885	13
Rnuisance	0.259	0.211	0	0.721
DistRoissy	26.74	10.11	6	45
Scenic	0.082	0.109	0	0.381
Elevation	0.103	0.085	0	0.304
Green	9.07	11.83	0.078	57.11
Monuments	0.210	0.429	0	2.37
Shopping	66.78	42.57	14.55	282.79
Auditoria	0.288	0.395	0	1.45
Playgrounds	0.841	0.774	0	3.88
Retax	15.15	4.87	6.49	28.22
Dtax	12.15	2.45	6.41	19.3
Poverty	33.67	6.91	20.7	55.24
Year1986	0.102	0.303	0	1
Year1987	0.117	0.321	0	1
Year1988	0.110	0.313	0	1
Year1989	0.116	0.321	0	1
Year1990	0.126	0.332	0	1
Year1991	0.110	0.313	0	1
Year1992	0.100	0.301	0	1
Year1993	0.106	0.308	0	1

Table 3: Estimation Results

Variable	Coef.	Std. Err.	95% Conf. Interval	
Lambda	-0.128**	0.011	-0.151	-0.106
C	5.917**	0.310	5.307	6.526
Second room	0.066**	0.009	0.048	0.085
Third room	0.049**	0.007	0.036	0.063
Fourth room	0.034**	0.005	0.024	0.044
Fifth room	0.034**	0.005	0.024	0.044
Sixth room	0.032**	0.005	0.022	0.043
Another room	0.023**	0.003	0.016	0.031
Equipped kitchen	0.017**	0.002	0.012	0.023
Parking	0.017**	0.002	0.011	0.022
Balcony	0.011**	0.002	0.007	0.016
House	0.043**	0.006	0.031	0.055
Basement	0.004**	0.001	0.001	0.007
Garden	0.006**	0.002	0.002	0.010
Garden size	0.00006**	0.00001	0.00004	0.00008
Peer	-0.0005**	0.0002	-0.0009	-0.0002
Student/teacher	-0.002*	0.0008	-0.003	-0.0003
Ptransport	-0.0008**	0.0001	-0.001	-0.0004
Ctransport	-0.0006**	0.0002	-0.001	-0.0002
Acmotorway	-0.002**	0.0004	-0.002	-0.001
Rnuisance	-0.032**	0.005	-0.043	-0.020
DistRoissy	0.0006**	0.0001	0.0003	0.0009
Scenic	0.029**	0.009	0.010	0.048
Elevation	0.039**	0.011	0.016	0.062
Green	0.0002**	0.00009	0.00004	0.0004
Monuments	0.008**	0.002	0.004	0.012
Shopping	0.0001**	0.00002	0.00008	0.0001
Auditoria	0.023**	0.003	0.015	0.031
Playgrounds	0.004**	0.001	0.002	0.006
Retax	-0.001**	0.0003	-0.002	-0.001
Dtax	-0.001**	0.0004	-0.002	-0.0009
Poverty	-0.001**	0.0002	-0.002	-0.001
Year1986	0.025**	0.004	0.017	0.034
Year1987	0.050**	0.007	0.035	0.064
Year1988	0.075**	0.010	0.054	0.096
Year1989	0.108**	0.015	0.078	0.138
Year1990	0.136**	0.019	0.099	0.174
Year1991	0.148**	0.020	0.107	0.189
Year1992	0.146**	0.020	0.106	0.186
Year1993	0.138**	0.019	0.100	0.176
Number of observations		8192		
Log likelihood		-93428.6		
Test H_0	Restricted $\lg L$	$\chi^2(1)$	$\text{Pr} > \chi^2$	
Lambda = -1	-99565.396	5513.25	0.000	
Lambda = 0	-93491.246	125.31	0.000	
Lambda = 1	-97670.453	8483.73	0.000	

** Coefficient significantly different from zero at the 0.01 level

* Coefficient significantly different from zero at the 0.05 level

Table 4: Hedonic Price of Urban Amenities

Variable name	Hedonic price (Euros)	Elasticity (%)
Peer	255	0.0659
Student/teacher	854	0.2212
Ptransport	345	0.1631
Ctransport	276	0.2744
Acmotorway	857	0.0302
Rnuisance	1881	0.0050
DistRoissy	275	0.0756
Scenic	168	0.0001
Elevation	225	0.0002
Green	98	0.0091
Monuments	482	0.001
Shopping	59	0.0404
Auditoria	4105	0.0121
Playgrounds	733	0.0063
REtax	718	0.1119
Dtax	773	0.0967
Poverty	670	0.2322

Table 5: Cost-Benefit Comparisons of Public Spending for Reducing School Failure

	(1)	(2)	(3)	(4)	(5)	(6)
	% of owners 1990 census	Number of housing units 1990 census	Total benefit of a permanent reduction of school failure by 1 point (in thousand of euros)	Total public spending including capital expenditures 1993 (in thousand of euros)	Annual benefit of a reduction of school failure by 1 point (in thousand of euros)	Public spending excluding capital expenditure 1993 (in thousand of euros)
• Argenteuil	43%	34113	3520	3441	123	77
• Bezons	44%	9423	1040	980	36	25
• Garges les Gonnesses	34%	12842	820	2640	29	75
• Goussainville	58%	7940	1349	1464	47	33
• Persan	36%	3402	2645	1251	93	14
• Saint Ouen l'Aumône	43%	6101	553	927	19	16
• Sarcelles	33%	17607	1237	1407	43	42
• Villiers le Bel	39%	9102	656	1182	23	45
Total	-	-	11820	13291	414	327

(1) (2) : INSEE CENSUS 1990

(3) : (1)x (2)x MWP for the city

(4) (6) : Financial appendix : Town contract 1994-1998 Sources : Mission-Ville Département du Val d'Oise

(5) : (3)x 0.035