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Hedonic Valuation of Marginal Willingness to Pay for Air Quality in Metropolitan Damascus

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Abstract

This study has two objectives. The first is to estimate the household's marginal willingness to pay (MWTP) for air quality improvement in metropolitan Damascus. The second objective is to test the performance of the hedonic valuation technique in a developing country context using Damascus as a case study. Results from a survey of 421 households show that the technique performs satisfactorily. Air pollution has a significant negative effect on housing value. The average households' MWTP for a unit decrease in total suspended particulates (TSP) concentration is estimated at about US$60.00 (in 2002 dollars). Simple segmentation of the housing market shows that estimates drawn from the pooled sample tend to underestimate the average MWTP of upper-income households occupying spacious housing-units, and overestimate that of lower-income households occupying units with less preferable characteristics.

1. Introduction:

Environment has become one of the leading issues of development, and environmental valuation is a basic tool of sound environmental policy. Among several families of valuation methods, the hedonic price technique has been extensively used to measure the effect of urban air pollution on property values in developed urban centers. Unfortunately, applications dedicated for developing urban centers are rare, and very little is known about the effect of air pollution on households' welfare in cities such as Damascus, one of the major urban centers in the Middle East, where pollution has reached alarming levels.[1] Total suspended particulates (TSP) emitted by diesel-engine motor vehicles are of main concern because of their huge volume of emissions and high visibility of effect compared to other pollutants. The overall average concentration of TSP in 2000 for Damascus City was 246 $\mu g/m^3$ (micro grams per cubic meter).[2] Nonetheless, empirical studies on air-pollution-related welfare effects have not been attempted. Therefore, the first objective of this study is to estimate households' average willingness to pay for a marginal improvement in air quality. The second objective is to test the validity of applying the hedonic method to Damascus City. Damascus should serve as a suitable laboratory for this method given the variation in pollution levels within the city, and the simplicity of the common housing types.

Since the pioneering study by Ridker and Hennings (1967), the hedonic price technique has survived lengthy debates concerning several issues.[3] Rosen (1974) provided the theoretical basis for hedonic empirical applications, and subsequently the debate was not about the validity of the

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application or the interpretation of hedonic regression results, but rather on issues related to identification of the functional form and market segmentation among others. The debate on the identification of the functional form has eventually shifted in favor of simple functional forms (See Haab and McConnell 2003: 259). The issue of housing market segmentation is still receiving interest, especially from housing economists. This issue is addressed and empirically tested insofar as pollution effect on property value is concerned.

In an early assessment of the hedonic method, Freeman (1979a) noted that "There is much to be learned by studying new cities ..." Since then, the number of investigated cities has increased rapidly, especially in the US. This paper adds a new entry from the developing world to the list of cities studied so far. The results show that the hedonic technique is no less powerful when applied to a typical developing urban center such as Damascus. The major drawback is the lack of data sources, and efforts must be made to collect micro-data by means of interviews. In the ideal circumstances, the researcher can collect a relatively small sample with the advantage of the ability to obtain data on each observation, rather than averages from aggregated data.

The remainder of this paper is organized as follows: the second section addresses the targeted market scope and data issues. The third section discusses the model used in estimation. The fourth section presents the estimation results and analysis of marginal benefit. Finally, the last section consists of summary and conclusions.

2. Market Scope and Data Issues

There are only two housing types in Damascus, the traditional house, *beit arabi*, and the modern concrete-built flat house, *beit afranji*. The supply of the former has been decreasing, and is being replaced with modern concrete buildings. Traditional houses located within the ancient part of the city are considered to be national heritage sites, and those outside are included in plans for future development. Moreover, transactions involving this type of housing are relatively rare and are based mainly on expectations for future development. As can be expected, this type of housing is excluded from the study since the majority of residents live in modern flats. Two small districts are excluded from the sample. These elite districts are inaccessible by the medium-income residents due to their exceptionally high prices, and are also small in terms of relative area and population. Inserting these into the model creates an outlier of extreme gravity.

The data used in this study include published data and primary data collected by means of a survey questionnaire and direct observation. The published data include only the levels of TSP concentrations recorded by the monitoring stations spread out across residential areas in the city. TSP data are available for thirteen residential areas representative of the city. The level of TSP concentration refers to the twenty-four-hour average concentration calculated as the average of the minimum and maximum readings recorded by the given monitoring stations during the late summer

of the year 2000.[4] The data required to apply the hedonic technique to Damascus are not available from sources similar to Census of Population or Household's Surveys or other sources typically used in earlier studies. The data collection is based on a survey questionnaire completed by the interviewee during the interview. A local team of data collectors was recruited and supervised directly by the author. The survey covers 421 households randomly selected from thirteen areas representing metropolitan Damascus. The preliminary questionnaire included a large set of variables suggested by both empirical literature and "expert" advice. After a two-week test in the field, the questionnaire was simplified considering the comments of both data collectors and interviewees. It was noted that interviewees tend to cooperate less the longer they expect the interview to be, and the more it contains "personal" questions.

In each district or neighborhood, there is one or more of small-scale real estate agencies. Theses agencies provide valuable information on recent sales in the real estate market. They were of much help in checking and testing the questionnaire, providing advice on market segmentation and also in securing interviews with housing unit owners. Property value and household's income data were obtained directly from the property owners. Data on the structural quality (equivalent to the age of the house) are based on statement given by owner or senior residents during the interview. Observation and information obtained from relevant local real-estate agencies are also used to check the level of structural quality of housing units. Data on accessibility and neighborhood location were obtained by direct observation and measurement.

3. The Model

The hedonic function relates the value of the housing unit (stock variable) or the rent of the housing unit (flow variable) to structural, neighborhood, accessibility, and environmental variables. This function represents a *double envelope* of bid and offer curves (Rosen 1974).[5] The hedonic function need not be linear (Freeman 1979a), and the identification of the proper functional form remains an empirical issue with no guidance from theory.[6] In the context of this study, the hedonic equation is written in the double-log form (offering the best statistical fit) as:

$$\begin{aligned} ln(\text{PRICE}) = {} & \beta_1 + \beta_2 ln(\text{AREA}) + \beta_3 ln(\text{ROOM}) + \beta_4 ln(\text{FLRLEV}) + \beta_5 \text{HQSTR} + \beta_6 \text{LQSTR} + \\ & \beta_7 \text{LIGHT} + \beta_8 \text{DNBR} + \beta_9 \text{LHMG} + \beta_{10} ln(\text{HEALTH}) + \beta_{11} ln(\text{CENTER}) + \\ & \beta_{12} ln(\text{INCOME}) + \beta_{13} ln(\text{TSP}) \end{aligned}$$

where each independent variable represents one characteristic of the housing unit. The dependent variable in the equation is defined as the market price of the housing unit as stated by the house owner.[7] The independent variables in the same equation are listed in Table 1 with summary statistics, and are briefly discussed in what follows.

Structural characteristics include the square area of the housing unit (AREA), the floor level (FLRLEV), the number of rooms (ROOM), the main windows direction (LIGHT), and two dummy variables (HQSTR and LQSTR) to account for the quality of building structure. MQSTR is the omitted category that defines the reference group for the last two dummy variables, so that a nonzero HQSTR (LQSTR) refers to a structural quality premium (discount) relative to the average level. These three levels of structural quality are adopted instead of the age of housing unit, a variable typically used to proxy the condition of the housing unit. It is evident that an aged housing unit with good structure is usually preferred to a newer one with lower structural quality, and the same argument can be found in other studies.[8]

The data required for characteristics such as the crime rate or the exact ratio of non-permanent residents are not available at the neighborhood level, but, given the nature of the city, few levels of the given characteristic should be sufficient. Neighborhood characteristics include a dummy variable (DNBR) to differentiate between housing units built along main roads or in areas where small-scale manufacturing activities are concentrated on the one hand, and those that are not on the other. It is evident that the latter characteristic is generally preferred to the former. A dummy variable (LHMG) is used to account for the level of homogeneity in terms of the percentage of permanent residents. Statistics are not available for this percentage but the distribution of relevant areas is well known to residents. The fact that a given area has a high percentage of immigrants or refugees has no bearing on consumers' market accessibility, but it is evident that most people prefer areas of higher homogeneity.

Variables of accessibility are all measured in average minutes of commuting time. These include the distance from the commercial center of the city (CENTER), and the nearest health service (HEALTH). The last variable should also be thought of as a proxy of the level of population density because doctors tend to choose populous areas with an acceptable level of security. Finally, the environmental characteristics include only one variable used as a proxy for air pollution, namely, the TSP concentration.

Table 1: Definitions and Summary Statistics of Independent Variables

Variable	Definition	Mean	Std. dev.	Exp. Sign
AREA	Area of owner-occupied house (squared meter)	112.0	22.25	+
ROOM	The number of rooms.	4.69	1.03	+
FLRLEV	The number of floor level (2^{st}F, 3^{nd}F, 3^{rd}F, …)	4.76	1.93	-
HQSTR (Dummy)	= 1 for newly built units and unit with good structure. =0 other wise	0.143	0.350	+
LQSTR (Dummy)	= 1 for units with low-quality structure. = 0 otherwise.	0.150	0.357	-
LIGHT (Dummy)	= 1 for unites with main windows facing south. = 0 otherwise.	0.35	0.48	+
DNBR (Dummy)	= 1 for highly developed neighborhood. = 0 otherwise	0.60	0.49	+
LHMG (Dummy)	= 1 for areas with low percentage of permanent residents. = 0 otherwise	0.138	0.48	-
HEALTH	Distance from nearest health services (min.).	6.3	5.27	-
CENTER	Distance from city center (min.).	20.4	9.43	-
INCOME	The average monthly income of the household estimated by the housing-unit's owner or senior resident (SP)	15669.8	5378.66	+
TSP	The monitoring station's Average reading of the twenty-four-hour concentration of total suspended particulates measured in micro grams per cubic meter.	261.5	60.16	-

Notes: SP or Syrian Pound is the official name of the Syrian currency. The exchange rate is SP50 for US$1.00. min = minutes spent in commuting by means of public transportation (Bus).

4. Estimation Results

Regression estimation results are listed in column (1) of Table 2. Results from further analysis (columns 2 to 7) are also reported in Table 2 to save space, but will be discussed later. Since heteroskedasticity is a typical problem in the estimation of housing hedonic equations, it was feared that a genuine heteroskedasticity would arise.[9] Surprisingly, a double-log transformation was sufficient to eliminate heteroskedasticity, while other transformations, including the commonly used semi-log transformation, have failed to pass one or more of the commonly used heteroskedasticity tests (Bartlet's, Golffeld's, White's, and Glejser's tests were used). Tests for collinearity resulted in the culling of some variables (not included in Table 1).[10]

Table 2: Regression Estimation Results

Variable	(1) Total Sample	(2) Area 1	(3) Area 2	(4) Income 1	(5) Income 2	(6) Center 1	(7) Center 2
C	*** 4.787	*** 5.128	*** 3.955	*** 5.879	*** 4.897	*** 4.263	*** 3.077
	(0.55096)	(1.02131)	(0.91755)	(1.01549)	(1.04139)	(0.78976)	(0.86464)
AREA	*** 1.338	*** 1.132	*** 1.555	*** 1.264	*** 1.393	*** 1.505	*** 1.128
	(0.08382)	(0.18280)	(0.16177)	(0.11376)	(0.12050)	(0.12171)	(0.11188)
ROOM	*** 0.308	* 0.162	*** 0.440	*** 0.259	*** 0.402	*** 0.436	** 0.205
	(0.06978)	(0.09126)	(0.10832)	(0.08512)	(0.10663)	(0.10847)	(0.09005)
FLRLEV	-0.039	-0.038	-0.034	-0.026	-0.046	0.0003	-0.040
	(0.02544)	(0.03452)	(0.03812)	(0.03206)	(0.04369)	(0.0376)	(0.03394)
HQSTR	*** 0.155	0.096	*** 0.146	*** 0.203	* 0.098	*** 0.123	0.108
	(0.03906)	(0.07975)	(0.04741)	(0.06874)	(0.04968)	(0.04814)	(0.06588)
LQSTR	*** -0.103	-0.048	*** -0.200	-0.064	*** -0.512	-0.085	* -0.080
	(0.03737)	(0.04562)	(0.06550)	(0.03981)	(0.11748)	(0.06331)	(0.04433)
LIGHT	** 0.060	0.038	0.058	0.048	** 0.084	0.047	* 0.073
	(0.02592)	(0.03648)	(0.03740)	(0.03264)	(0.04209)	(0.03366)	(0.03837)
DNBR	*** 0.227	*** 0.211	*** 0.238	*** -0.145	0.080	*** 0.150	*** -0.168
	(0.02782)	(0.03898)	(0.04017)	(0.04838)	(0.09339)	(0.09419)	(0.04518)
LHMG	*** -0.135	*** -0.189	-0.057	*** -0.213	*** -0.159	*** -0.106	** 0.337
	(0.04068)	(0.05073)	(0.07301)	(0.03267)	(0.03594)	(0.04344)	(0.15977)
HEALTH	*** -0.115	*** -0.109	*** -0.126	*** 0.162	*** 0.329	*** 0.217	*** 0.202
	(0.01521)	(0.02085)	(0.02323)	(0.03404)	(0.04848)	(0.03745)	(0.03953)
CENTER	*** -0.181	*** -0.182	*** -0.181	*** -0.140	* -0.051	*** -0.050	*** -0.147
	(0.02434)	(0.03482)	(0.03445)	(0.01887)	(0.02736)	(0.02545)	(0.02313)
INCOME	*** 0.530	*** 0.644	*** 0.447	*** 0.482	*** 0.433	*** 0.399	*** 0.679
	(0.05393)	(0.07841)	(0.07477)	(0.11016)	(0.08846)	(0.07285)	(0.08014)
TSP	*** -0.260	*** -0.306	*** -0.192	*** -0.276	*** -0.216	*** -0.167	*** -0.308
	(0.04848)	(0.07053)	(0.06961)	(0.06099)	(0.07187)	(0.07453)	(0.06757)
Adj. R^2	0.85	0.78	0.79	0.79	0.79	0.79	0.87

Note: ***, **, * stands for 1%, 5%, 10% levels of significance respectively. Standard errors are in brackets.

A look at column (1) of Table 2 shows that all the coefficients are significantly different from zero with one exception, FLRLEV.[11] All coefficients have the expected sign and their magnitudes are comfortably reasonable. The marginal implicit prices of housing characteristics are not constant due to the nonlinearity of the hedonic function. The marginal implicit price of the variable of interest, TSP, is calculated by differentiating the hedonic price function with respect to TSP. Therefore, for a given household, each unit-increment in TSP concentration results in an estimated decrease in housing-unit value of -.026 times housing-unit value divided by the associated TSP level. For example, a household whose housing-unit's value is US$30,000.00 with associated level of TSP at 223 $\mu g/m^3$ suffers a marginal damage of US$35. The same household's marginal benefit of a unit decrease in TSP concentration is equivalently US$35. In other words, this particular household is expected to be willing to pay no more than US$35 to avoid the damage to property value associated with a one unit-increase in TSP concentration.[12] Denoting the size of the sample by N, the sample's

average MWTP is calculated as the average of marginal damages which is equal to:

$$N^{-1} \Sigma [(\delta p / \delta tsp)(p_i / tsp_i)] = \text{US\$-60.06} \approx \text{SP-3,000.00.}$$

Thus, if the sample is fairly representative of metropolitan Damascus, an average household should be willing to pay about US$60 for a unit-decrease in the surrounding level of air pollution proxied by the level of TSP concentration.[13] Needless to say, the benefit is capitalized in the property, and the associated MWTP is not to be thought of as a payment per some unit of time, but rather as a lump sum payment for moving from the status quo to a lower level of surrounding air pollution.

So far, the two objectives of the study are satisfactorily met. The hedonic technique seems to perform very well, and a reasonable estimation is obtained. However, since several studies argued that the housing market should be segmented on the ground that the coefficients estimated from the pooled sample might turn out to be imprecise or even faulty (See Freeman 1979b: 142-143; Palmquist 1991: 89-91), it is worthwhile to check the implications of possible market segmentation to the estimated MWTP. The question is on what basis the market should be segmented. Upon consultation with real-estate experts, it was found that the city cannot be split into north/south or east/west segments, and the best procedure was to segment the city into two rings, where the inner ring represents housing units with high accessibility, and the outer ring represents housing units with lower level of accessibility.[14]

However, there is still a need to identify the border that separates the two rings. There are no strictly clear barriers to segment the market, but a Chow test shows that the regression equation could be split into two regressions with respect to CENTER, and the associated border is almost half way from the center of the city to the farthest housing unit included in the sample. The same statistical procedure shows that the market could also be segmented into two segments with respect to AREA, and also with respect to INCOME. Thus, the sample is divided and re-estimated on the basis of three different criteria as shown below, and summary statistics for each subsample is available from Table 3.

1- Area 1 (AREA < 120 square meter) and Area 2 (AREA >= 120 square meter)
2- Income 1 (INCOME < SP15000) and Income 2 (INCOME >= SP15000)
3- Center1 (CENTER < 20 minutes) and Center 2 (CENTER >= 20 minutes)

A rough procedure to test whether these three types of segmentation are justified is to run segment-level regressions and see if there is a large difference in magnitude between coefficients obtained from each segment. The double log transformation is applied to all segments. The results of these regressions are summarized in Table 2 (columns 2-7).

Table 3: Subsamples' summary statistics

Variable	Area 1		Area 2		Income 1		Income 2		Center 1		Center 2	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
AREA	94.28	9.00	127.28	18.65	104.15	16.63	125.18	24.25	115.30	21.41	108.16	22.65
ROOM	4.22	0.83	5.10	1.02	4.40	0.88	5.18	1.08	4.91	0.99	4.43	1.01
FLRLEV	4.77	1.98	4.75	1.88	4.81	1.89	4.67	1.98	4.77	1.90	4.75	1.97
HQSTR	0.06	0.23	0.22	0.41	0.06	0.24	0.28	0.45	0.18	0.39	0.10	0.30
LQSTR	0.23	0.42	0.08	0.28	0.23	0.42	0.02	0.14	0.08	0.27	0.23	0.42
LIGHT	0.36	0.48	0.35	0.48	0.36	0.48	0.34	0.48	0.42	0.49	0.28	0.45
DNBR	0.48	0.50	0.69	0.47	0.47	0.50	0.80	0.40	0.70	0.46	0.46	0.50
LHMG	0.22	0.42	0.07	0.25	0.19	0.39	0.05	0.22	0.04	0.19	0.26	0.44
CENTER	22.08	9.32	18.88	9.28	21.77	9.09	17.99	9.54	12.78	5.48	29.15	3.58
HEALTH	7.13	5.07	5.08	4.03	7.06	5.51	4.82	4.13	3.96	3.15	8.43	4.96
INCOME	13613	4177	17467	5506	12722	2035	20659	5351	16653	5129	14556	5266
TSP	265.49	56.91	258.07	62.74	259.76	57.80	264.45	64.01	264.88	66.81	257.60	51.28

Results show that the TSP coefficient is significantly different from zero at the 1% level of significance for all segments, and the same is true for almost all crucial variables. In general, the explanatory power of the model is not affected by segmentation. The dummy variables were rather fragile, a matter that should be attributed to the fact that segmentation results in less variation in some variables on the one-segment level.[15] However, our interest is in the effect of market segmentation on the estimated MWTP for air quality. Table 4 summarizes the estimated average MWTP calculated for each market segment in the third row. The number of observations included in each segment (segment size) is reported in the second row. The last column refers to the previous result obtained from the total sample.

Table 4: Calculated Average MWTP (average marginal benefit)

Segment	**Area1**	**Area2**	**Income1**	**Income2**	**Center1**	**Center2**	**Pooled**
Size of Segment	195	226	264	157	226	195	421
Segment Av. MWTP	-42.1	-60.7	-45.8	-74.9	-45.9	-57.2	-60

It is clear from Table 4 that the average MWTP of the upper-income households is remarkably higher than that of lower-income households. The same is true for household enjoying spacious living area compared to household occupying relatively small-sized units. Residents of the inner ring have remarkably lower WTP compared to those of the outer ring. This should not be surprising for real-estate economists who are aware of the possibility of such outcomes.[16] Further rigorous

analysis of segmentation is beyond the scope of this paper, but the main idea in this context is that segmentation should be used in line with the purpose of the study. If one is only interested in raising an issue, then an overall estimation should be sufficient. But, if policymakers are interested in a specific segment of the market or with a specific income-group of residents then segmentation has insights to offer.

5. Summary and Conclusions

This empirical study has shown that the hedonic price method can be validly applied to Damascus City to obtain estimates of the marginal damage to housing value caused by air pollution. The high significance of the pollution coefficient in both the pooled sample and all subsamples regressions shows that pollution is indeed depressing the housing value. The sample household's average MWTP for a unit-decrease in TSP concentration is estimated at a reasonable amount of US$60.00.

Market segmentation shows that average estimates can vary significantly across segments. But, in line with conclusions drawn from previous hedonic studies, the results obtained from segmentation are not of crucial importance if one is only interested in an overall estimation. Clearly, there is a trade-off between the desire for more variation in the values of variables and the insights one could make from segmentation. Since the market could arguably be segmented according to more than one criterion, the question is not which criterion produces better estimations, but it rather depends on the purpose of the policymaker.

Further research should be directed at the estimation of aggregate MWTP and discrete WTP for a given environmental improvement by applying discrete choice model estimation procedure based on housing choice, or using an appropriate form of contingent valuation. Finally, it is hoped that this study will encourage researchers to undertake similar studies in other urban centers in the region.

Notes:

1 Several factors are behind the vehicular pollution problem. High urbanization rates have resulted in high population density. The resulting increasing demand for mobility and mass transportation is causing traffic congestion. The aging vehicles' fleet size and fuel quality also exacerbate the problem. Moreover, the topography of the city is unfavorable.

2 For a comparison of levels of urban air pollution among cities of the world refer to Table 13.3 in World Development Indicators 2003, World Bank.

3 See Freeman (1979a; 1979b) for a discussion of early issues.

4 The data was published about two years later. See Meslmani and Soliman (2002).

5 A compact account of Rosen's theory can be found in Palmquist (1991) or Freeman (2003). A simplified presentation is available in Kolstad (2000).

6 The desire for improving the statistical fit beyond what is offered by simple transformation has led econo-

metricians to develop more complicated transformations. Goodman (1978) introduced the use of linear Cox-Box transformation. Halverson and Pollakowski (1981) introduced the highly general and flexible quadratic Cox-Box transformation that renders simple transformations as special cases. These transformations were criticized on technical and computational grounds, and the accumulated empirical evidence was in support of simple forms. For a brief discussion of this issue refer to Palmquist (1991) and Haab (2003).

7 Since data on actual market transactions are the most preferred, owners were asked to state the amount they actually paid to purchase their property. It is not clear whether occupants have an incentive not to provide the true value of their property. Kiel and Zabel (1999) analyzed an American Census data set and found that owners tend to overvalue their property by about 5%, but concluded that hedonic equations based on these data produced unbiased estimates of housing characteristics.

8 See for example the study of Anderson and Crocker (1971)

9 For a recent discussion about empirical evidence on heteroskedasticity in hedonic housing models see Stevenson (2004).

10 Outputs from tests of normality, heteroskedasticity, and collinearity are available from the author upon request.

11 FLRLEV is not discarded on the basis that at least it has produced the expected sign with level of significance just above the cutoff level of 10%.

12 The theory justifiably suggests that an individual should be willing to pay an amount of money that does not exceed the welfare gain from the proposed environmental improvement, as reflected in the positive change in the property value. However, nothing in reality guarantees that the individual would actually pay any given amount of money for some specified improvement. Contingent valuation studies, for example, have typically faced a problem of protest bids.

13 Care should be taken when comparing this MWTP estimate with estimates produced by other studies addressing different cities. It is important to see whether the given study uses TSP as a proxy of air pollution or as one of several environmental variables included in the model. Differences in per capita income and in the level of peoples' awareness of air pollution across cities are also important factors. Smith and Huang (1995) surveyed a large number of hedonic studies of air pollution undertaken between 1967 and 1988. They found a mean MWTP of US$109.90 (in 1982-84 dollars) with a wide range of variation across cities.

14 Relying on “expert” advice as an approach to market segmentation was suggested by Michaels and Smith (1990). Other earlier approaches are discussed in Palmquist 1991.

15 Examples can be checked from Table 3. First, variables of structural quality are less significant in the outer ring of the city (Center2), suggesting that structural quality of housing units shows more similarity in the suburbs compared to down town where more variety is available in terms of housing units' age and structural quality. Second, Area2 regression results show that housing units located in areas of low homogeneity tends to be smaller in size.

16 However, the issue of housing market segmentation and prediction of estimates is still being debated among housing economists whose interest is not centralized on the relatively small effect of pollution on property value. See Bourassa (2003) for a recent discussion.

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