**The Demand for Air Quality: Evidence from the Housing Market in Bogotá, Colombia**

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# ONLINE APPENDIX

## 1. Theoretical construction of the Hedonic Price Model (HPM)

Taylor (2003) offers the following description of the HPF: if Z is a 'differentiated product' which is determined by its characteristics, this means that

$$Z = (z_1, \dots, z_n)\,, \tag{A1}$$

where n is the number of characteristics of the differentiated good.

At the same time, it is assumed that Z is sold in a competitive market. The price schedule or price function for a characteristic is denoted as $p(Z)$: $\mathbb{R}^n \to \mathbb{R}$. Kolstad (2000) affirms that, "The price function is an equilibrium concept, resulting from the interaction of supply and demand. In much the same way that conventional supply and demand interact to produce a single market price, forces of supply and demand interact to produce a price function…" Thus, the consumer is price acceptant because $p(Z)$ is exogenous.

The utility of the consumers depends on the differentiated good Z and on a composite good X[1] (Palmquist, 2005). Additionally, this utility is affected by the socioeconomic characteristics of the agent, which are denoted as $\alpha_i$. Thus, the utility for the individual $i$ is defined by

$$U^i(X, Z, \alpha_i)\colon \mathbb{R}^{n+1} \to \mathbb{R}. \tag{A2}$$

At the same time, in the model it is assumed that the consumer buys just one unit of the good Z, so the income restriction can be expressed like:

$$y^i = X + p(Z) \tag{A3}$$

Palmquist (2005) affirms that in the presence of consumers with more than one residence, it is assumed that each one of them has a different purpose. Accordingly, they will enter separately in the utility function.

[1] Palmquist (2005) describes X as a "Hicksian composite good".

Thus, the consumer's problem is to

$$\max_{X,Z} U^i(X, Z, \alpha_i) \;\; s.a \;\; y^j = X + p(Z), \tag{A4}$$

so that n of the n+1 first order conditions could be summarized in the following expression

$$\frac{\partial p(Z)}{\partial z_j} = p_j = \frac{\dfrac{\partial U^i(X, Z, \alpha_i)}{\partial z_j}}{\dfrac{\partial U^i(X, Z, \alpha_i)}{\partial X}} \text{ para j} = 1, \dots, \text{n} \tag{A5}$$

The consumer has to decide which is his optimal bid for the house; this means its willingness to pay. The consumer's "*Bid Function*" describes the relationship between the bid that the consumer would make for Z, based on changes on one or more of its characteristics, keeping constant the utility and its income (Taylor, 2003). Thus, if $y_0^i - \theta^i = X$, the utility of the agent *i* can be expressed as:

$$U^i\left(y_0^i - \theta^i, Z, \alpha_i\right) \equiv U_0^i \;, \tag{A6}$$

from (A6):

$$\theta^i = \theta^i\left(Z, y_0^i, U_0^i, \alpha_i\right). \tag{A7}$$

From the previous equations, the consumer problem can be expressed as

$$\max_{Z} U^i(y^i - \theta^i(Z, y^i, U^i, \alpha_i), Z, \alpha_i) \;\; , \tag{A8}$$

the first order conditions of the maximization problem in (A8)

$$\frac{\partial U^i(\cdot)}{\partial X}(-1)\frac{\partial \theta^i(\cdot)}{\partial z_j} + \frac{\partial U^i(\cdot)}{\partial z_j} = 0 \;\; para\; j = 1, \dots, n \tag{A9}$$

This implies,

$$\frac{\partial \theta^i\left(Z, y^i, U^i, \alpha_i\right)}{\partial z_j} = \frac{\dfrac{\partial U^i(X, Z, \alpha_i)}{\partial z_j}}{\dfrac{\partial U^i(X, Z, \alpha_i)}{\partial X}} \; para\; j = 1, \dots, n \,. \tag{A10}$$

By comparing (A5) to (A10), in the optimum

$$\frac{\partial p(Z)}{\partial z_j} = \frac{\partial \theta^i\left(Z, y^i, U^i, \alpha_i\right)}{\partial z_j} = \frac{\frac{\partial U^i(X, Z, \alpha_i)}{\partial z_j}}{\frac{\partial U^i(X, Z, \alpha_i)}{\partial X}} \qquad (A11)$$

for each consumer and characteristic. This means that at the optimum, the consumer´s offer for one more unit of the $z_j$ characteristic ($\frac{\partial \theta^i(Z, y^i, U^i, \alpha_i)}{\partial z_j}$) is exactly equal to the marginal effect of this change on the price of Z. In other words, what the consumer pays is equivalent to what the market will charge him (her).

## 2. Robustness Checks

There are at least two identification issues to consider: the evidence in favor of the existence of three submarkets defined by type of dwelling, and how results might change using an alternative measure of air quality, or different functional forms for the HPF.

A Chow test was used to check for structural changes in the HPF among the housing submarkets. By calculating an equivalent Chow test for the frontier model of the general case, we found that a structural change exists ($\chi^2 = 354.7$) between the three submarkets based on the specified functional form. Another exercise was to use the Two Step Clustering method as in Poudyal *et al.* (2009). We estimated the optimum number of clusters and the cluster structure using cadastral data, which captures the census of all Bogotá's dwellings. The methodology predicts three submarkets: apartments (cluster 1), houses without horizontal property (cluster 2), and houses with horizontal properties, similar to the market structure that this document uses.[2]

We also used as a robustness check different functional forms of the hedonic function as well as different air quality measures. As suggested by Cropper *et al.* (1988) and Kuminoff *et al.* (2010), simple functional forms such as semi-log or log models are preferred. Air quality

[2] Please see table A7 in the online appendix reporting the output of the cluster methodology.

parameters were negative and significant for most of the functional forms' specifications and submarkets. We also compared the results of the FS using OLS estimations to the FS frontier model. OLS results are also consistent with a negative and statistically significant effect of PM10 concentration on housing rents; the implicit price elasticity for air quality based on OLS estimations were 21 per cent higher than in the benchmark frontier model specified to mitigate Omitted Variable Bias.

Regarding various air quality measures, table RC1 reports the air quality estimated parameter using the annual PM10 concentration average, interpolated by VNA (column 1, the same results are reported in table 2), daily mean concentration interpolated by Inverse Distance Weighting (IDW) (column 4), which is a more standard interpolation method, mean maximum daily concentration (column 5), and mean daily concentration of PM10 during the EMB time framework. For all variables and submarkets the price-pollution relationships are still negative and almost all are statistically significant at least at the 10% level.[3]

Table RC1. *First Stage with different pollution measures*

| | ß | IC- | IC+ | ß - IDW | ß - Mean Survey | ß - Annual Max |
|---|---|---|---|---|---|---|
| General | -0.01537 | -0.00979 | -0.02095 | -0.00914 | -0.00649 | -0.00303 |
| | | | | (0.00189) | (0.00549) | (0.00021) |
| Apartment | -0.00612 | -0.00045 | -0.01180 | -0.00187 | -0.00050 | -0.00081 |
| | | | | (0.51649) | (0.82776) | (0.39885) |
| Condos | -0.02764 | 0.02033 | -0.07561 | -0.05101 | -0.02935 | -0.00830 |
| | | | | (0.00206) | (0.01607) | (0.10124) |
| No-condos | -0.02165 | -0.00944 | -0.03386 | -0.02299 | -0.01344 | -0.00812 |
| | | | | (0.00319) | (0.04163) | (0.00007) |

Relevance test p-value in parentheses

[3] Table A9 in the online appendix goes further by exploring the robustness of results to different functional forms.

The SS demand function is robust to the measurement of air quality (using IDW results), to changes of functional form (log-log specification), to model specification for FS estimation (using results of OLS with Spatial fixed effects) and to changes of instruments for the SS (using only precipitation as the instrument). None of the mentioned changes had major consequences on the significance of the negative relationship between price and quantity of the estimated demand.[4] Our main goal was the estimation of Total Willingness to Pay (TWP) for PM10 reductions, thus, robustness should be seen primarily in terms of these results. Table RC2 below summarizes the welfare estimations for the general case of the proposed estimation and the robustness exercises. In some cases, results converge either to similar elasticities or to similar welfare measures. For example, when using data from the IDW interpolation method, welfare measures for achieving both the national standard and the WHO standard are higher but not much higher than those derived by the proposed model. Interestingly, welfare measures are quite robust to different instrument specifications. For example, welfare measures and elasticity estimations do not change significantly between the benchmark specification and a specification using only wind speed but not raining data.

*Table RC 2. Total Willingness to Pay (robustness exercises)*

| | Elasticity (%) | TWP for 20µg/m³ | | TWP for 50µg/m³ | |
|---|---|---|---|---|---|
| Proposed Model | -1.306023 | 189.64 | [21.04] | 12.16 | [1.35] |
| Log – Log | -1.911331 | 198.29 | [22] | 32.88 | [3.65] |
| Log – Lin | -2.007038 | 115.51 | [12.82] | 6.33 | [.7] |
| IDW | -.9417697 | 207.47 | [23.02] | 13.62 | [1.51] |
| OLS with spatial fix effects | -1.582098 | 94.26 | [10.46] | 5.97 | [.66] |
| Instrumented by wind speed and spatial lag | -1.311581 | 189.38 | [21.02] | 12.14 | [1.35] |
| Instrumented just by wind speed | -1.030766 | 206.35 | [22.9] | 13.5 | [1.5] |

Percentage of monthly income in square brackets

[4] Tables A9 to A14 in the online appendix show different estimations, changing the measurement of air quality, functional form, and instruments.

## 3. Additional tables and figures

Table A1. *Dwelling and neighborhood characteristics*

| Variables | Description | N | Mean | SD | Min. | Max |
|---|---|---|---|---|---|---|
| *Structural and Neighborhood Characteristics* | | | | | | |
| arriendo | Living in rent (Yes or no) | 11,643 | .3865 | .487 | 0 | 1 |
| numCuartos | Number of rooms | 11,643 | 3.63 | 1.324 | 1 | 15 |
| banios | Number of bathrooms | 11,631 | 1.593 | .8211 | 1 | 9 |
| garaje | Garage (Yes or no) | 11,643 | .4109 | .492 | 0 | 1 |
| arriendoReal | Rent for renters (US$) | 4,500 | 251.3 | 219.5 | 12 | 3,790 |
| arriendoAuto | Hypothetical rent (US$) | 7,143 | 395.6 | 380.7 | 14 | 3,790 |
| PArrien | Aggregated rent (US$) | 11,643 | 339.8 | 335.4 | 12 | 3,790 |
| ascensor | Elevator (Yes or no) | 11,643 | .1328 | .3394 | 0 | 1 |
| terraza | Terrace (Yes or no) | 11,643 | .2854 | .4516 | 0 | 1 |
| zonVerdes | Green areas (Yes or no) | 11,643 | .2949 | .456 | 0 | 1 |
| numTelFijo | Number of fixed phones | 11,643 | .8012 | .5068 | 0 | 5 |
| internet | Internet (Yes or no) | 11,643 | .4738 | .4993 | 0 | 1 |
| conjunCerr | In a residential complex (Yes or no) | 11,643 | .3007 | .4586 | 0 | 1 |
| jardin | Garden (Yes or no) | 11,643 | .4084 | .4916 | 0 | 1 |
| pisos | Number of levels in the building | 11,643 | 3.479 | 2.909 | 1 | 30 |
| plancha | Plate (Yes or no) | 11,544 | .8482 | .3588 | 0 | 1 |
| humedad | Moistness (Yes or no) | 11,619 | .3581 | .4795 | 0 | 1 |
| inseguridad | Insecurity (Yes or no) | 11,643 | .757 | .4289 | 0 | 1 |
| homicidios | Mean number of murders during last ten years in the block | 11,643 | 330.8 | 239.4 | 0 | 1,900 |
| precipitacion | 2011 mean rainfall (mm/month) | 11,643 | .3341 | .8821 | 0 | 14 |
| ruido | Noise (Yes or no) | 11,643 | .3673 | .4821 | 0 | 1 |
| malOlor | Odor (Yes or no) | 11,643 | .3832 | .4862 | 0 | 1 |
| indComSer | Near industry, commerce or services (Yes or no) | 11,643 | .3728 | .4836 | 0 | 1 |
| anunciosExc | Advertising (Yes or no) | 11,643 | .08142 | .2735 | 0 | 1 |
| invasionAndenes | Advertising (Yes or no) | 11,643 | .1611 | .3677 | 0 | 1 |
| cuartDormi | Number of rooms available for sleeping | 11,643 | 2.2107 | 0.9413 | 1 | 9 |
| calentador | Water heater (Yes or no) | 11,643 | 0.5424 | 0.4982 | 0 | 1 |
| aireLib | Access to terrace or Green areas (Yes or no) | 11,643 | 0.7882 | 0.4086 | 0 | 1 |
| cocinaExcl | Private kitchen (Yes or no) | 11,643 | 1.9861 | 0.1309 1 | 0 | 2 |
| fallViv | Dwelling present moistness, sinking or pipeline failures (Yes or no) | 11,628 | 0.3967 | 0.4892 | 0 | 1 |
| puntaje | Mean building's quality score in the block level | 11,643 | 41.32 | 15.03 | 10 | 91 |
| distFuenCont | Distance to fix sources of pollution (m) | 11,643 | 751.5 | 571.5 | 0 | 3,365 |
| *Categorical variables* | | | | | | |
| matPisos | Floors predominant material | | | | | |
| matParedes | Walls predominant material | | | | | |
| ubiAgua | Water source in the house | | | | | |
| dondCocina | Cooking area | | | | | |
| combCocina | Cooking combustible | | | | | |
| viaEstado | Quality of dwellings' roads of access | | | | | |
| viaIlumin | Quality of ilumintaion in the road of access | | | | | |
| localidad | Localitie (Bogota's principal political division) where the dwelling is located | | | | | |

Table A2. *Description of socio-demographic variables*

| Variable | Description | N | Mean | SD | Min. | Max. |
|---|---|---|---|---|---|---|
| sexoJH | Sex of HH (1=man) | 11,643 | .616 | .4864 | 0 | 1 |
| edadJH | Age of HH | 11,643 | 48.23 | 15.09 | 16 | 99 |
| meanAge | Mean age within families | 11,643 | 35.97 | 15.49 | 8 | 92 |
| tiemBogJH | Time living in Bogotá (years) | 11,643 | 37.14 | 19.77 | 0 | 99 |
| perHog | Number of people per house | 11,643 | 3.382 | 1.64 | 1 | 19 |
| hog_hijos | Number of sons | 11,643 | 1.297 | 1.127 | 0 | 9 |
| ingresos | Income (US$) | 10,993 | 901.1 | 1,554 | 0 | 54,143 |
| menores_5 | Number of children under 5y | 11,643 | .2286 | .4987 | 0 | 4 |
| men5Tos | Children under 5y with cough during the last week | 11,643 | .0931 | .3228 | 0 | 3 |
| men5DifRes | Children under 5y with breath difficulties during the last week | 11,643 | .02499 | .1683 | 0 | 3 |
| hog_orgAmb | Number of family members in environmental organization | 11,643 | .01589 | .1369 | 0 | 3 |
| trabaja | Marital status of HH | 11,507 | .717 | .4505 | 0 | 1 |

Table A3. *PM10 Air Quality data*

| Variable | Description | N | Mean | SD | Min. | Max |
|---|---|---|---|---|---|---|
| meanStock | PM10 Annual Concentration (ug/m3) | 11,643 | 52.84 | 9.294 | 38 | 84 |
| meanEnc | PM10 mean dailly Concentration while EMB (ug/m3) | 11,643 | 59.3 | 9.724 | 40 | 88 |
| maxStock | PM10 Max Concentration (ug/m3) | 11,643 | 255.4 | 39.48 | 176 | 376 |
| inter2meanPM | PM10 concentration by VNA (ug/m3) | 6,077 | 48.64 | 7.718 | 38 | 84 |
| SO2 | $SO_2$ mean annual concentration (PPB) | 11,643 | 2.9 | 1.142 | 0.934 | 8.365 |
| CO | CO mean annual concentration (PPM) | 11,643 | 0.9 | 0.128 | 0.657 | 1.507 |
| O3 | $O_3$ mean annual concentration (PPB) | 11,643 | 11.09 | 1.925 | 7.97 | 16.398 |

Table A4. *Correlation matrix between pollutants*

| | meanStock | inter2meanPM | CO | O3 | SO2 |
|---|---|---|---|---|---|
| meanStock | 1 | | | | |
| inter2meanPM | 0.9573 | 1 | | | |
| | (0.0000) | | | | |
| CO | 0.8383 | 0.718 | 1 | | |
| | (0.0000) | (0.0000) | | | |
| O3 | -0.603 | -0.5992 | -0.3357 | 1 | |
| | (0.0000) | (0.0000) | (0.0000) | | |
| SO2 | 0.9072 | 0.8397 | 0.9453 | -0.4303 | 1 |
| | (0.0000) | (0.0000) | (0.0000) | (0.0000) | |

P-value of individual significance test in parentheses

Table A5. *Hedonic Price Function estimation*

| | (1)<br>All | (2)<br>Apart. | (3)<br>House in Condos | (4)<br>House no Condos |
|---|---|---|---|---|
| lnrent | | | | |
| PM10 | -.015372*** | -.0061217** | -.024383* | -.021776*** |
| | (0.0028) | (0.0029) | (0.0131) | (0.0062) |
| inter2meanPM_arr | .0029179** | .0021535 | .0053419 | .0025825 |
| | (0.0013) | (0.0015) | (0.0060) | (0.0033) |
| arriendo | -.5351** | -.40505 | -1.1933** | -.87396 |
| | (0.2471) | (0.2627) | (0.5495) | (0.5404) |
| numCuartos | .065031*** | .069829*** | .029764 | .049269*** |
| | (0.0059) | (0.0082) | (0.0218) | (0.0100) |
| pisos | -.010301*** | .0071155*** | | -.0019179 |
| | (0.0031) | (0.0024) | | (0.0221) |
| banios | .17178*** | .16237*** | .1287*** | .12296*** |
| | (0.0089) | (0.0116) | (0.0317) | (0.0169) |
| cuartDormir | .0042259 | -.0011395 | -.0047237 | .0063024 |
| | (0.0068) | (0.0086) | (0.0236) | (0.0124) |
| calentador | .042664*** | .013347 | | |
| | (0.0140) | (0.0170) | | |
| aireLib | .064505*** | .034332** | .0904 | .038869 |
| | (0.0153) | (0.0156) | (0.0681) | (0.0425) |
| ascensor | .090834*** | | | |
| | (0.0238) | | | |
| numTelFijo | .043708*** | .071417*** | | .022028 |
| | (0.0144) | (0.0164) | | (0.0293) |
| cocinaExcl | .22167** | .14947 | | .14607 |
| | (0.1008) | (0.1078) | | (0.1948) |
| internet | .063874*** | .059659*** | | .097931*** |
| | (0.0134) | (0.0155) | | (0.0267) |
| DmatPisos3 | -.022391 | -.027149 | -.092397** | -.012973 |
| | (0.0162) | (0.0175) | (0.0443) | (0.0410) |
| DmatPisos4 | -.028231 | -.0045639 | -.33872*** | -.018855 |
| | (0.0224) | (0.0242) | (0.0783) | (0.0540) |
| DmatPisos5 | -.010598 | .0067745 | -.14214* | -.026525 |
| | (0.0257) | (0.0285) | (0.0836) | (0.0584) |
| DmatPisos6 | -.17272*** | -.27322*** | -.088762 | -.12429 |
| | (0.0470) | (0.0743) | (0.1198) | (0.0792) |
| DmatPisos7 | -.070204 | .30109 | | -.16928 |
| | (0.2817) | (0.2794) | | (0.2851) |

Table A5. *Hedonic Price Function estimation (continued)*

| | (1)<br>All | (2)<br>Apart. | (3)<br>House in Condos | (4)<br>House no Condos |
|---|---|---|---|---|
| fallViv | -.014298 | -.015083 | | -.0003099 |
| | (0.0122) | (0.0143) | | (0.0246) |
| DmatParedes2 | -.019264 | -.037212 | | |
| | (0.0264) | (0.0307) | | |
| DmatParedes3 | -.0011155 | -.0099306 | | |
| | (0.0123) | (0.0141) | | |
| DmatParedes4 | -.019484 | -.0029611 | | |
| | (0.0444) | (0.0651) | | |
| DmatParedes5 | -.37901*** | -.27076 | | |
| | (0.1310) | (0.2551) | | |
| DmatParedes6 | .08459 | .0035294 | | |
| | (0.1717) | (0.3793) | | |
| DmatParedes7 | -.88938* | | | |
| | (0.4971) | | | |
| DubiAgua2 | -.0027236 | -.013971 | .172* | -.054736 |
| | (0.0337) | (0.0397) | (0.0956) | (0.0677) |
| DubiAgua3 | -.012483 | -.012386 | | -.02587 |
| | (0.1081) | (0.1068) | | (0.3698) |
| DubiAgua4 | -.086798 | -.098687 | | -.17851 |
| | (0.1494) | (0.1337) | | (0.2703) |
| DdondCocina2 | -.014937 | .13692 | | -.23998 |
| | (0.1109) | (0.1291) | | (0.2103) |
| DdondCocina3 | -.10774 | .17592 | | .07899 |
| | (0.0988) | (0.1388) | | (0.2397) |
| DdondCocina4 | -.065143 | -.047105 | | -.26143 |
| | (0.2645) | (0.2191) | | (0.3911) |
| DdondCocina5 | -.024636 | .025241 | | -.16083 |
| | (0.2645) | (0.2213) | | (0.2449) |
| DdondCocina6 | -.22511 | | | -.31676 |
| | (0.2773) | | | |
| homicidios | -.017381** | -.011348 | -.099515** | -.006772 |
| | (0.0075) | (0.0082) | (0.0390) | (0.0174) |
| inseguridad | -.0083373 | -.022874 | .070555* | .011359 |
| | (0.0134) | (0.0147) | (0.0404) | (0.0308) |
| distFuenCont | .0000258 | .0000296 | | -.0000264 |
| | (0.0000) | (0.0000) | | (0.0000) |

Table A5. *Hedonic Price Function estimation (continued)*

| | (1)<br>All | (2)<br>Apart. | (3)<br>House in Condos | (4)<br>House no Condos |
|---|---|---|---|---|
| puntaje | .011197*** | .011308*** | .015223*** | .016965*** |
| | (0.0008) | (0.0009) | (0.0024) | (0.0022) |
| indComSer | -.0069347 | -.017009 | | |
| | (0.0124) | (0.0143) | | |
| anunciosExc | -.0079866 | -.040132* | | |
| | (0.0199) | (0.0232) | | |
| invasionAndenes | .021109 | -.007327 | | |
| | (0.0151) | (0.0168) | | |
| DviaIlumin2 | .0034486 | -.020031 | | |
| | (0.0132) | (0.0154) | | |
| DviaIlumin3 | -.0097587 | -.0052178 | | |
| | (0.1194) | (0.1498) | | |
| DviaEstado2 | -.021764 | -.038892** | .04645 | |
| | (0.0155) | (0.0188) | (0.0537) | |
| DviaEstado3 | -.031181 | .0087599 | -.2043 | |
| | (0.0259) | (0.0319) | (0.1275) | |
| DviaEstado4 | -.041126 | .020925 | -.037357 | |
| | (0.0546) | (0.0587) | (0.1515) | |
| numCuartos_arr | .017406 | .020936 | -.0020945 | .0016248 |
| | (0.0111) | (0.0129) | (0.0615) | (0.0251) |
| pisos_arr | .011789** | .001501 | | -.024327 |
| | (0.0049) | (0.0038) | | (0.0391) |
| banios_arr | -.02623 | -.016885 | -.049486 | -.012749 |
| | (0.0165) | (0.0189) | (0.0639) | (0.0414) |
| cuartDormir_arr | .047792*** | .032765** | .1548*** | .062115* |
| | (0.0133) | (0.0147) | (0.0586) | (0.0324) |
| calentador_arr | .0115 | .026481 | | |
| | (0.0221) | (0.0242) | | |
| aireLib_arr | -.068423*** | -.065297*** | .070971 | .047757 |
| | (0.0227) | (0.0226) | (0.1551) | (0.0728) |
| ascensor_arr | -.016743 | | | |
| | (0.0395) | | | |
| numTelFijo_arr | -.042799** | -.073748*** | | -.040944 |
| | (0.0214) | (0.0229) | | (0.0543) |
| cocinaExcl_arr | .033198 | .034166 | | .26662 |
| | (0.1152) | (0.1219) | | (0.2330) |

Table A5. *Hedonic Price Function estimation (continued)*

| | (1)<br>All | (2)<br>Apart. | (3)<br>House in Condos | (4)<br>House no Condos |
|---|---|---|---|---|
| internet_arr | .0012088 | .0031749 | | -.056659 |
| | (0.0220) | (0.0233) | | (0.0568) |
| DmatPisos3_arr | .031005 | .018358 | .21272* | .0651 |
| | (0.0290) | (0.0288) | (0.1199) | (0.1111) |
| DmatPisos4_arr | -.011956 | -.021389 | .3904** | -.054408 |
| | (0.0377) | (0.0379) | (0.1566) | (0.1285) |
| DmatPisos5_arr | -.0063366 | -.01774 | .3961* | -.013484 |
| | (0.0438) | (0.0450) | (0.2130) | (0.1410) |
| DmatPisos6_arr | .071817 | .20341** | .043658 | -.05533 |
| | (0.0709) | (0.0985) | (0.3134) | (0.1547) |
| DmatPisos7_arr | -.18871 | | | -.28053 |
| | (0.3485) | | | (0.4626) |
| fallViv_arr | -.035629* | -.026462 | | -.062963 |
| | (0.0199) | (0.0214) | | (0.0515) |
| DmatParedes2_arr | .013932 | .015672 | | |
| | (0.0418) | (0.0442) | | |
| DmatParedes3_arr | .0007494 | -.0066011 | | |
| | (0.0199) | (0.0212) | | |
| DmatParedes4_arr | .0034505 | .010016 | | |
| | (0.0747) | (0.0919) | | |
| DmatParedes5_arr | .14741 | .20993 | | |
| | (0.2158) | (0.3420) | | |
| DmatParedes6_arr | -.31457 | | | |
| | (0.3102) | | | |
| DubiAgua2_arr | -.033876 | -.037619 | | .087847 |
| | (0.0561) | (0.0623) | | (0.1179) |
| DubiAgua3_arr | .018871 | .069673 | | |
| | (0.2123) | (0.2039) | | |
| DubiAgua4_arr | -.016596 | -.023827 | | |
| | (0.1914) | (0.1791) | | |
| DdondCocina2_arr | -.010989 | -.11327 | | .045054 |
| | (0.1630) | (0.1824) | | (0.3284) |
| DdondCocina3_arr | -.032122 | -.24595 | | -.32627 |
| | (0.1293) | (0.1762) | | (0.3467) |
| DdondCocina4_arr | .056529 | | | |
| | (0.3621) | | | |

Table A5. *Hedonic Price Function estimation (continued)*

| | (1)<br>All | (2)<br>Apart. | (3)<br>House in Condos | (4)<br>House no Condos |
|---|---|---|---|---|
| DdondCocina5_arr | -.16757 | .11238 | | |
| | (0.3055) | (0.3047) | | |
| homicidios_arr | .018275* | .0095691 | .15455** | .019083 |
| | (0.0101) | (0.0106) | (0.0613) | (0.0268) |
| inseguridad_arr | -.0075902 | .0076646 | -.27237*** | -.030031 |
| | (0.0211) | (0.0219) | (0.1039) | (0.0598) |
| distFuenCont_arr | 2.69e-06 | -.0000196 | | .0000316 |
| | (0.0000) | (0.0000) | | (0.0001) |
| puntaje_arr | .0017793 | .000856 | -.0003746 | -.00222 |
| | (0.0012) | (0.0012) | (0.0061) | (0.0044) |
| indComSer_arr | .012978 | .032735 | | -.013946 |
| | (0.0198) | (0.0211) | | (0.0473) |
| anunciosExc_arr | -.0097475 | .018952 | | .032984 |
| | (0.0334) | (0.0357) | | (0.0750) |
| invasionAndenes_arr | -.041807 | .0006611 | | -.0753 |
| | (0.0259) | (0.0267) | | (0.0657) |
| DviaIlumin2_arr | .031968 | .05043** | | .076804 |
| | (0.0215) | (0.0230) | | (0.0478) |
| DviaIlumin3_arr | .097818 | .10475 | | .20111 |
| | (0.1539) | (0.1803) | | (0.2309) |
| DviaEstado2_arr | .011309 | .0019734 | -.14168 | .095804* |
| | (0.0247) | (0.0270) | (0.1460) | (0.0538) |
| DviaEstado3_arr | -.027709 | -.09546** | .19338 | -.05722 |
| | (0.0435) | (0.0486) | (0.2032) | (0.0878) |
| DviaEstado4_arr | .06769 | .037084 | .21725 | -.072165 |
| | (0.0829) | (0.0890) | (0.3710) | (0.1833) |
| CO | .67184*** | .54141*** | -.96809 | .90066** |
| | (0.1779) | (0.2021) | (1.0685) | (0.4120) |
| SO2 | -.050516** | -.066538** | .10485 | -.037957 |
| | (0.0240) | (0.0282) | (0.1333) | (0.0484) |
| O3 | .012656** | .017121*** | -.074452* | -.01454 |
| | (0.0059) | (0.0060) | (0.0423) | (0.0211) |
| 1.localidad | 0 | 0 | 0 | 0 |
| | (.) | (.) | (.) | (.) |
| 2.localidad | .085845* | .087635** | | -.16339 |
| | (0.0446) | (0.0407) | | (0.3603) |

Table A5. *Hedonic Price Function estimation (continued)*

| | (1)<br>All | (2)<br>Apart. | (3)<br>House in Condos | (4)<br>House no Condos |
|---|---|---|---|---|
| 3.localidad | -.18233*** | -.22474*** | -.97632*** | -.22744 |
| | (0.0627) | (0.0652) | (0.3539) | (0.4052) |
| 4.localidad | -.3062*** | -.3488*** | | -.44226 |
| | (0.0922) | (0.0931) | | (0.3831) |
| 6.localidad | -.14898* | -.15492** | | -.16098 |
| | (0.0848) | (0.0737) | | (0.3635) |
| 8.localidad | -.099101 | -.42125*** | -.35 | .0919 |
| | (0.0880) | (0.0804) | (0.4285) | (0.3577) |
| 9.localidad | -.0084299 | -.06586 | -.45089 | -.15214 |
| | (0.0649) | (0.0588) | (0.2949) | (0.3197) |
| 10.localidad | -.32114*** | -.36906*** | -.67777*** | -.31368 |
| | (0.0584) | (0.0617) | (0.2357) | (0.3130) |
| 11.localidad | -.19098*** | -.23917*** | -.23457 | -.16362 |
| | (0.0449) | (0.0443) | (0.1755) | (0.3051) |
| 12.localidad | -.13262*** | -.27799*** | -.14947 | .039731 |
| | (0.0492) | (0.0508) | (0.2148) | (0.3165) |
| 13.localidad | -.030834 | -.1951*** | .011039 | .43007 |
| | (0.0517) | (0.0566) | (0.3384) | (0.3094) |
| 14.localidad | -.17126*** | -.2603*** | | -.23845 |
| | (0.0574) | (0.0561) | | (0.3440) |
| 15.localidad | -.10404* | -.28902*** | .43844 | -.066819 |
| | (0.0584) | (0.0581) | (0.3711) | (0.3399) |
| 16.localidad | -.16758** | -.23037*** | -.45653 | -.26788 |
| | (0.0725) | (0.0661) | (0.3555) | (0.3492) |
| 17.localidad | .086969 | .14668* | | -.035157 |
| | (0.0842) | (0.0803) | | (0.5840) |
| 18.localidad | -.20175*** | -.28428*** | -.58612* | -.24641 |
| | (0.0642) | (0.0665) | (0.3341) | (0.3495) |
| tanqAgua | | .031344** | -.15112*** | |
| | | (0.0140) | (0.0418) | |
| conjunCerr | | -.027873* | | |
| | | (0.0155) | | |

Table A5. *Hedonic Price Function estimation (continued)*

| | (1)<br>All | (2)<br>Apart. | (3)<br>House in Condos | (4)<br>House no Condos |
|---|---|---|---|---|
| DcombCocina2 | | .0092477 | .012336 | |
| | | (0.0180) | (0.0697) | |
| DcombCocina3 | | -.030222 | .18355 | |
| | | (0.0360) | (0.1561) | |
| DcombCocina4 | | .26886 | | |
| | | (0.3092) | | |
| tanqAgua_arr | | -.010668 | .22473*** | |
| | | (0.0206) | (0.0866) | |
| conjunCerr_arr | | .046354* | | |
| | | (0.0239) | | |
| DcombCocina2_arr | | .02818 | .23527 | |
| | | (0.0277) | (0.1808) | |
| DcombCocina3_arr | | -.046722 | -.10424 | |
| | | (0.0470) | (0.2535) | |
| DcombCocina4_arr | | -.4383 | | |
| | | (0.3386) | | |
| lavadero | | | -.18407* | |
| | | | (0.1014) | |
| lavadero_arr | | | .14308 | |
| | | | (0.1816) | |
| garaje | | | | .14267*** |
| | | | | (0.0292) |
| garaje_arr | | | | .064829 |
| | | | | (0.0605) |
| Constant | 4.6848*** | 4.543*** | 8.3833*** | 5.0767*** |
| | (0.2765) | (0.2986) | (1.0803) | (0.7562) |

Table A5. *Hedonic Price Function estimation (continued) – Asymmetric Variance Function (Hedonic Frontier Model)*

| | (1)<br>All | (2)<br>Apart. | (3)<br>House in Condos | (4)<br>House no Condos |
|---|---|---|---|---|
| Constant | -2.3132*** | -2.6197*** | -3.547*** | -2.0072*** |
| | (0.0360) | (0.0393) | (0.2904) | (0.0487) |
| lnsig2u | | | | |
| PM10 | .021559 | .263* | .069413 | -.61459 |
| | (0.1867) | (0.1564) | (0.1155) | (1.7330) |
| 1.localidad | 0 | 0 | 0 | 0 |
| | (.) | (.) | (.) | (.) |
| 2.localidad | .70105 | .28982 | | -16.967 |
| | (0.4691) | (0.3668) | | (4360.1195) |
| 3.localidad | -1.1231* | -1.5068** | .39925 | 3.1378 |
| | (0.6530) | (0.6488) | (1.6642) | (12.6043) |
| 4.localidad | -.84964 | -1.4013* | | 1.3068 |
| | (0.7670) | (0.7209) | | (12.7945) |
| 6.localidad | -.19284 | .22377 | | -6.5506 |
| | (1.1874) | (0.5730) | | (174.4877) |
| 8.localidad | .52588 | -32.757 | .098763 | 4.5069 |
| | (1.2311) | (5371.3371) | (2.1778) | (12.5208) |
| 9.localidad | 1.0777* | .20519 | -.14683 | -18.763 |
| | (0.6385) | (0.4718) | (1.2337) | (1003.3409) |
| 10.localidad | -2.0998* | -2.0721*** | -2.5977 | -2.7955 |
| | (1.0845) | (0.7640) | (.) | (18.6521) |
| 11.localidad | .087188 | -.60339 | 1.432 | 2.7346 |
| | (0.4538) | (0.4096) | (0.9503) | (12.5811) |
| 12.localidad | .080845 | -1.2473** | -.77322 | 4.0724 |
| | (0.4288) | (0.4876) | (0.7453) | (12.5257) |
| 13.localidad | 1.1687** | -.83868 | .078414 | 5.9173 |
| | (0.4690) | (0.6101) | (1.1609) | (12.3719) |
| 14.localidad | .35479 | -.81068* | | 2.2339 |
| | (0.5350) | (0.4715) | | (12.7364) |
| 15.localidad | .13053 | -1.4713*** | 2.5441** | 3.8431 |
| | (0.4818) | (0.4846) | (1.2911) | (12.5336) |
| 16.localidad | 1.0721* | -.18329 | .22243 | 2.0502 |
| | (0.6475) | (0.5453) | (1.5290) | (12.7637) |
| 17.localidad | .33337 | .093245 | | 4.201 |
| | (0.5272) | (0.4568) | | (12.6907) |
| 18.localidad | .79989 | -.36995 | -.45648 | 3.6518 |
| | (0.5381) | (0.4792) | (1.7249) | (12.5565) |

Table A5. *Hedonic Price Function estimation (continued) – Asymmetric Variance Function (Hedonic Frontier Model)*

| | (1)<br>All | (2)<br>Apart. | (3)<br>House in Condos | (4)<br>House no Condos |
|---|---|---|---|---|
| 2.estrFinal#c.inter2m | -.15481 | -.36473** | | .5513 |
| eanPM | (0.1890) | (0.1566) | | (1.7393) |
| 3.estrFinal#c.inter2m | -.18605 | -.31125** | -.12485* | .46649 |
| eanPM | (0.1877) | (0.1546) | (0.0734) | (1.7386) |
| 4.estrFinal#c.inter2m | -.18186 | -.33191** | -.19171 | .51779 |
| eanPM | (0.1867) | (0.1540) | (0.1301) | (1.7371) |
| 5.estrFinal#c.inter2m | -.25185*** | -.31439*** | -2.2839 | |
| eanPM | (0.0294) | (0.0236) | (1311.7614) | |
| 1.estrFinal | 0 | 0 | | 0 |
| | (.) | (.) | | (.) |
| 2.estrFinal | 4.755 | 14.54** | 0 | -27.987 |
| | (8.2416) | (6.8384) | (.) | (78.8039) |
| 3.estrFinal | 4.9464 | 10.855 | 6.5396 | -24.943 |
| | (8.1508) | (6.7280) | (4.3028) | (78.6711) |
| 4.estrFinal | 3.8944 | 11.003 | 9.5183 | -27.502 |
| | (8.1180) | (6.6990) | (6.4596) | (78.5452) |
| 5.estrFinal | 5.7356 | 9.3095 | 75.945 | -7.1616 |
| | (.) | (.) | (54882.7625) | (15.4630) |
| 6.estrFinal | -32.943 | -30.686 | -9.1389 | |
| | (618.7509) | (418.2796) | (8.2966) | |
| Constant | -.1478 | -10.399 | -6.1786 | 25.702 |
| | (8.1466) | (6.7895) | (6.0575) | (69.8236) |
| $R^2$ | | | | |
| N | 6,061 | 4,153 | 319 | 1,562 |
| Est. Var. | oim | oim | oim | oim |

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A6. *Demand for PM10 reduction estimation by 2SLS*

| | (1)<br>First Stage PM10 | (2)<br>Second Stage |
|---|---|---|
| PM10 | | -.057522*** |
| | | (0.0133) |
| Rainfall | -.0057113** | |
| | (0.0026) | |
| Wind speed | 19.996*** | |
| | (5.9213) | |
| Wind speed² | -9.3602*** | |
| | (3.1687) | |
| Wind speed³ | 1.4206*** | |
| | (0.5423) | |
| WPM10 | 1.0011*** | |
| | (0.0176) | |
| Income | -5.03e-06 | .0001854*** |
| | (0.0000) | (0.0001) |
| educMasAlta | .0039801 | .13915*** |
| | (0.0099) | (0.0512) |
| sexoJH | .0072044 | .16051 |
| | (0.0294) | (0.1262) |
| edadJH | .0008034 | .030495*** |
| | (0.0013) | (0.0064) |
| tiemBogJH | .000333 | -.0009991 |
| | (0.0008) | (0.0047) |
| hog_hijos | -.0041393 | -.18256* |
| | (0.0144) | (0.0987) |
| hog_orgAmb | .036098 | .19915 |
| | (0.0772) | (0.4925) |
| menores_5 | -.0045431 | -.34139** |
| | (0.0283) | (0.1723) |
| men5Tos | .0048016 | -.057857 |
| | (0.0387) | (0.2458) |
| men5DifRes | -.0053862 | .27923 |
| | (0.0552) | (0.4358) |

Table A6. *Demand for PM10 reduction estimation by 2SLS (continued)*

| | (1)<br>First Stage PM10 | (2)<br>Second Stage |
|---|---|---|
| perHog | -.0053309 | .19829** |
| | (0.0103) | (0.0805) |
| arriendo | -.009277 | -.98919*** |
| | (0.0411) | (0.1280) |
| numCuartos | .0014222 | 1.4776*** |
| | (0.0188) | (0.0835) |
| puntaje | -.0040868 | .017732** |
| | (0.0040) | (0.0083) |
| aireLib | -.069127* | 1.0549*** |
| | (0.0367) | (0.1435) |
| homicidios | .037244 | -.20033** |
| | (0.0292) | (0.0912) |
| inseguridad | .018274 | .037545 |
| | (0.0435) | (0.1444) |
| Constant | -13.31*** | -2.3394*** |
| | (4.3914) | (0.8696) |
| $R^2$ | | 0.279 |
| N | 5,694 | 5,694 |
| Hausman pValue | | 0.013 |
| Relevance pValue | | 0.000 |
| Hansen pValue | | 0.731 |
| Var. Est. | robust cluster | robust cluster |

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A7. *Two Step Clustering results*

| Cluster | 1 | 2 | 3 |
|---|---|---|---|
| Size | 40.7% | 12.3% | 47.0% |
| Entries | Apartments | Apartments | Apartments |
| | 0 (100%) | 0 (100%) | 1 (100%) |
| | Build Area | Build Area | Build Area |
| | 160.94 | 72.27 | 71.31 |
| | Land Area | Land Area | Land Area |
| | 104.65 | 69.80 | 35.96 |
| | Horizontal property | Horizontal property | Horizontal property |
| | 0 (100%) | 1 (100%) | 1 (100%) |
| | Year | Year | Year |
| | 1984.10 | 1999.58 | 1995.59 |

*Notes*: Table A7 replicates SPSS output for the Two-step Clustering algorithm. The first row identifies the proposed clusters, and assigns to each of them an id number. The second row presents the size of each cluster, as the percentage that each of them represents in the *CATASTRO* database. Finally, from row three onward, the algorithm shows the variable with which clusters were created. Results suggest that the variables $Apartments$ and $Horizontal\ property$ completely define the clusters. Hence the first group is defined by no-condos houses ($Apartments = 0$ and $Horizontal\ property = 0$), the second group corresponds to houses in condominiums ($Apartments = 0$ and $Horizontal\ property = 1$), and the third one corresponds to apartments ($Apartments = 1$ and $Horizontal\ property = 1$).

Table A8. *OLS estimation of Hedonic Price Function with spatial fixed effects*

| | (1)<br>All | (2)<br>Apart. | (3)<br>House in Condos | (4)<br>House no Condos |
|---|---|---|---|---|
| PM10 | -.0046074** | -.0045677* | -.01429* | -.0082987** |
| | (0.0020) | (0.0024) | (0.0084) | (0.0036) |
| inter2meanPM_arr | .0030557** | .0019761 | .0021704 | .0029045 |
| | (0.0014) | (0.0016) | (0.0053) | (0.0029) |
| arriendo | -.32736 | -.013404 | -.61886 | -.67975 |
| | (0.4181) | (0.5171) | (0.4769) | (0.4641) |
| numCuartos | .066669*** | .070988*** | .019992 | .057939*** |
| | (0.0078) | (0.0107) | (0.0410) | (0.0122) |
| pisos | -.012212*** | .0057968* | | -.0068527 |
| | (0.0042) | (0.0033) | | (0.0259) |
| banios | .18049*** | .18344*** | .20956*** | .11915*** |
| | (0.0124) | (0.0147) | (0.0515) | (0.0203) |
| cuartDormir | .0029746 | -.0030892 | .028503 | -.0064286 |
| | (0.0081) | (0.0097) | (0.0310) | (0.0155) |
| calentador | .049251*** | .018587 | | .089458*** |
| | (0.0176) | (0.0207) | | (0.0270) |
| aireLib | .061304*** | .033993* | .10334* | .074419* |
| | (0.0179) | (0.0195) | (0.0597) | (0.0448) |
| ascensor | .11889*** | | | |
| | (0.0310) | | | |
| numTelFijo | .049584*** | .067907*** | | .039872 |
| | (0.0187) | (0.0217) | | (0.0366) |
| cocinaExcl | .302 | .31327 | | .12621 |
| | (0.1893) | (0.2293) | | (0.1174) |
| internet | .072865*** | .067502*** | | .10401*** |
| | (0.0146) | (0.0173) | | (0.0293) |
| DmatPisos3 | -.033537* | -.036487* | -.081618 | -.020914 |
| | (0.0190) | (0.0203) | (0.0621) | (0.0490) |
| DmatPisos4 | -.035186 | -.019081 | -.37962*** | -.01592 |
| | (0.0255) | (0.0289) | (0.1236) | (0.0598) |
| DmatPisos5 | -.0087276 | -.0005532 | -.10635 | -.040926 |
| | (0.0297) | (0.0337) | (0.0759) | (0.0703) |
| DmatPisos6 | -.20627*** | -.35215*** | -.10763 | -.11745 |
| | (0.0658) | (0.0852) | (0.1120) | (0.1029) |
| DmatPisos7 | -.17144 | .32722*** | | -.13321 |
| | (0.3180) | (0.0697) | | (0.2698) |

Table A8. *OLS estimation of Hedonic Price Function with spatial fixed effects (continued)*

| | (1)<br>All | (2)<br>Apart. | (3)<br>House in Condos | (4)<br>House no Condos |
|---|---|---|---|---|
| fallViv | -.017488 | -.020818 | | -.017115 |
| | (0.0148) | (0.0172) | | (0.0296) |
| DmatParedes2 | -.023076 | -.032813 | | .0029843 |
| | (0.0355) | (0.0376) | | (0.0545) |
| DmatParedes3 | -.0028973 | -.014343 | | .038275 |
| | (0.0155) | (0.0182) | | (0.0264) |
| DmatParedes4 | -.023559 | .02188 | | -.032552 |
| | (0.0559) | (0.0754) | | (0.0634) |
| DmatParedes5 | -.46975*** | -.62146*** | | -.344** |
| | (0.1161) | (0.1681) | | (0.1461) |
| DmatParedes6 | .10008 | -.0025441 | | .069315 |
| | (0.2358) | (0.0585) | | (0.2037) |
| DmatParedes7 | -.81796*** | | | |
| | (0.2327) | | | |
| DubiAgua2 | -.013633 | -.017833 | .11002 | -.029702 |
| | (0.0439) | (0.0548) | (0.1009) | (0.0919) |
| DubiAgua3 | .045924 | .038111 | | .022608 |
| | (0.0443) | (0.0526) | | (0.0744) |
| DubiAgua4 | -.10434 | -.09405 | | -.112 |
| | (0.1425) | (0.1338) | | (0.0866) |
| DdondCocina2 | -.058544 | .17759 | | -.28539 |
| | (0.1675) | (0.1412) | | (0.2452) |
| DdondCocina3 | -.15588 | .25748 | | .059556 |
| | (0.1873) | (0.2688) | | (0.3425) |
| DdondCocina4 | -.11323 | .017653 | | -.26873** |
| | (0.1509) | (0.0688) | | (0.1310) |
| DdondCocina5 | .01456 | .06901 | | -.22682 |
| | (0.0600) | (0.0563) | | (0.2050) |
| DdondCocina6 | .0071264 | | | -.32741 |
| | (0.7128) | | | (0.9404) |
| homicidios | -.018552** | -.012564 | -.10655** | -.016679 |
| | (0.0085) | (0.0081) | (0.0507) | (0.0235) |
| inseguridad | -.013314 | -.027869 | .13612** | -.018984 |
| | (0.0151) | (0.0178) | (0.0575) | (0.0336) |
| distFuenCont | -5.34e-06 | .0000101 | | -.0000963* |
| | (0.0000) | (0.0000) | | (0.0001) |

Table A8. *OLS estimation of Hedonic Price Function with spatial fixed effects (continued)*

| | (1) All | (2) Apart. | (3) House in Condos | (4) House no Condos |
|---|---|---|---|---|
| puntaje | .015034*** | .015435*** | .013798*** | .021132*** |
| | (0.0012) | (0.0013) | (0.0033) | (0.0023) |
| indComSer | -.0041321 | -.0043714 | | .0063251 |
| | (0.0158) | (0.0180) | | (0.0317) |
| anunciosExc | -.0075159 | -.035551 | | .0021211 |
| | (0.0237) | (0.0244) | | (0.0481) |
| invasionAndenes | .022417 | .0031325 | | .061316 |
| | (0.0184) | (0.0193) | | (0.0413) |
| DviaIlumin2 | -.0013441 | -.024637 | | .037351 |
| | (0.0159) | (0.0186) | | (0.0294) |
| DviaIlumin3 | .0050059 | .026662 | | .089711 |
| | (0.1137) | (0.1278) | | (0.2044) |
| DviaEstado2 | -.021227 | -.031037 | .050405 | -.01417 |
| | (0.0187) | (0.0212) | (0.0821) | (0.0322) |
| DviaEstado3 | -.040266 | .0053685 | -.24811* | -.079389 |
| | (0.0348) | (0.0390) | (0.1247) | (0.0617) |
| DviaEstado4 | -.048171 | .0060945 | -.10789 | -.10222 |
| | (0.0583) | (0.0659) | (0.1281) | (0.1239) |
| numCuartos_arr | .018082 | .02054 | -.010019 | -.0066991 |
| | (0.0126) | (0.0146) | (0.0532) | (0.0253) |
| pisos_arr | .011778*** | .0022599 | | -.021216 |
| | (0.0043) | (0.0038) | | (0.0372) |
| banios_arr | -.02805 | -.032711 | -.086961 | .0088846 |
| | (0.0187) | (0.0214) | (0.0674) | (0.0393) |
| cuartDormir_arr | .049644*** | .039296** | .12211** | .074932** |
| | (0.0141) | (0.0165) | (0.0462) | (0.0297) |
| calentador_arr | .0082057 | .018317 | | |
| | (0.0245) | (0.0278) | | |
| aireLib_arr | -.060264** | -.053465** | .06119 | -.027039 |
| | (0.0240) | (0.0256) | (0.1130) | (0.0605) |
| ascensor_arr | -.0059993 | | | |
| | (0.0366) | | | |
| numTelFijo_arr | -.051335** | -.067801** | | -.09695 |
| | (0.0250) | (0.0267) | | (0.0623) |
| cocinaExcl_arr | -.054572 | -.13317 | | .22116 |
| | (0.1994) | (0.2464) | | (0.1859) |

Table A8. *OLS estimation of Hedonic Price Function with spatial fixed effects (continued)*

| | (1)<br>All | (2)<br>Apart. | (3)<br>House in Condos | (4)<br>House no Condos |
|---|---|---|---|---|
| internet_arr | -.0066045 | -.0041574 | | -.056454 |
| | (0.0229) | (0.0264) | | (0.0529) |
| DmatPisos3_arr | .025568 | .0092123 | .17044* | .082256 |
| | (0.0278) | (0.0293) | (0.0938) | (0.1165) |
| DmatPisos4_arr | -.014361 | -.024708 | .43798*** | -.063362 |
| | (0.0381) | (0.0429) | (0.1564) | (0.1272) |
| DmatPisos5_arr | -.008578 | -.017037 | .33499*** | .01017 |
| | (0.0416) | (0.0468) | (0.1194) | (0.1334) |
| DmatPisos6_arr | .065471 | .21089* | -.093935 | -.059241 |
| | (0.0858) | (0.1177) | (0.2144) | (0.1584) |
| DmatPisos7_arr | -.14444 | | | -.4349 |
| | (0.3298) | | | (0.3620) |
| fallViv_arr | -.034185* | -.024431 | | -.05428 |
| | (0.0201) | (0.0228) | | (0.0464) |
| DmatParedes2_arr | .010377 | .004583 | | |
| | (0.0482) | (0.0467) | | |
| DmatParedes3_arr | .0040624 | -.0051925 | | |
| | (0.0218) | (0.0246) | | |
| DmatParedes4_arr | .032694 | .01321 | | |
| | (0.0800) | (0.0974) | | |
| DmatParedes5_arr | .19028 | .25136 | | |
| | (0.1165) | (0.2107) | | |
| DmatParedes6_arr | -.30028 | | | |
| | (0.2595) | | | |
| DubiAgua2_arr | -.049697 | -.072379 | | .08555 |
| | (0.0632) | (0.0726) | | (0.1449) |
| DubiAgua3_arr | -.0026143 | .0064831 | | |
| | (0.1454) | (0.1707) | | |
| DubiAgua4_arr | .014592 | -.018885 | | |
| | (0.1593) | (0.1613) | | |
| DdondCocina2_arr | .05488 | -.11733 | | .16549 |
| | (0.1862) | (0.1716) | | (0.2506) |
| DdondCocina3_arr | .0077964 | -.30549 | | -.25552 |
| | (0.2181) | (0.2989) | | (0.3585) |
| DdondCocina4_arr | .1391 | | | |
| | (0.1763) | | | |

Table A8. *OLS estimation of Hedonic Price Function with spatial fixed effects (continued)*

| | (1)<br>All | (2)<br>Apart. | (3)<br>House in Condos | (4)<br>House no Condos |
|---|---|---|---|---|
| DdondCocina5_arr | -.23676 | .071583 | | |
| | (0.1970) | (0.1189) | | |
| DdondCocina6_arr | .58991 | | | 1.3917 |
| | (0.7588) | | | (0.9915) |
| homicidios_arr | .015581* | .0069284 | .11972* | .012195 |
| | (0.0090) | (0.0091) | (0.0659) | (0.0302) |
| inseguridad_arr | -.0098122 | .010179 | -.36481*** | -.0067433 |
| | (0.0209) | (0.0237) | (0.0989) | (0.0536) |
| distFuenCont_arr | 5.47e-06 | -.0000268 | | .0000819 |
| | (0.0000) | (0.0000) | | (0.0001) |
| puntaje_arr | .0011955 | .0007431 | .0002766 | -.0066609 |
| | (0.0013) | (0.0014) | (0.0060) | (0.0042) |
| indComSer_arr | .0090264 | .025042 | | -.016384 |
| | (0.0214) | (0.0246) | | (0.0507) |
| anunciosExc_arr | -.0094896 | .0089116 | | .038112 |
| | (0.0330) | (0.0376) | | (0.0710) |
| invasionAndenes_arr | -.038893 | -.0064112 | | -.14766* |
| | (0.0270) | (0.0274) | | (0.0771) |
| DviaIlumin2_arr | .040736* | .055063** | | .044555 |
| | (0.0219) | (0.0254) | | (0.0478) |
| DviaIlumin3_arr | .071015 | .046867 | | .1512 |
| | (0.1713) | (0.1885) | | (0.2122) |
| DviaEstado2_arr | .016982 | .0081085 | -.14332 | .12474** |
| | (0.0247) | (0.0281) | (0.1169) | (0.0574) |
| DviaEstado3_arr | -.013112 | -.073962 | .16996 | .045214 |
| | (0.0473) | (0.0574) | (0.1840) | (0.0884) |
| DviaEstado4_arr | .061208 | .025753 | -.017154 | .17438 |
| | (0.0831) | (0.0913) | (0.2709) | (0.1919) |
| 1.localidad | 0 | 0 | 0 | 0 |
| | (.) | (.) | (.) | (.) |
| 2.localidad | .065296 | .07192 | | -.17687 |
| | (0.0473) | (0.0514) | | (0.2469) |
| 3.localidad | -.15691*** | -.15608** | -.22579 | -.3393* |
| | (0.0573) | (0.0613) | (0.1953) | (0.1946) |
| 4.localidad | -.35096*** | -.34846*** | | -.40483** |
| | (0.0783) | (0.0971) | | (0.1574) |

Table A8. *OLS estimation of Hedonic Price Function with spatial fixed effects (continued)*

| | (1)<br>All | (2)<br>Apart. | (3)<br>House in Condos | (4)<br>House no Condos |
|---|---|---|---|---|
| 6.localidad | -.21581*** | -.25234*** | | -.15411 |
| | (0.0680) | (0.0771) | | (0.1559) |
| 8.localidad | -.21036*** | -.2558*** | .010669 | -.12283 |
| | (0.0736) | (0.0834) | (0.2622) | (0.1712) |
| 9.localidad | -.15619*** | -.15377*** | .12204 | -.23104 |
| | (0.0505) | (0.0561) | (0.1689) | (0.1513) |
| 10.localidad | -.21163*** | -.23024*** | -.18333 | -.25463** |
| | (0.0481) | (0.0537) | (0.1735) | (0.1246) |
| 11.localidad | -.2415*** | -.25436*** | -.16653 | -.27757** |
| | (0.0473) | (0.0526) | (0.1652) | (0.1296) |
| 12.localidad | -.14998*** | -.18682*** | .085702 | -.21062* |
| | (0.0477) | (0.0498) | (0.1603) | (0.1277) |
| 13.localidad | -.098824** | -.11888** | .36625** | -.13996 |
| | (0.0445) | (0.0483) | (0.1655) | (0.1337) |
| 14.localidad | -.2077*** | -.228*** | | -.23207* |
| | (0.0515) | (0.0595) | | (0.1269) |
| 15.localidad | -.17202*** | -.25237*** | .28988 | -.22146* |
| | (0.0510) | (0.0557) | (0.1948) | (0.1274) |
| 16.localidad | -.21451*** | -.25573*** | -.048224 | -.2276* |
| | (0.0547) | (0.0612) | (0.2020) | (0.1347) |
| 17.localidad | -.10328 | -.018197 | | -.29488 |
| | (0.0810) | (0.0890) | | (0.2926) |
| 18.localidad | -.34332*** | -.35432*** | .0084572 | -.3958*** |
| | (0.0560) | (0.0623) | (0.2041) | (0.1372) |
| tanqAgua | | .04161** | -.14652*** | |
| | | (0.0169) | (0.0553) | |
| conjunCerr | | -.037806* | | |
| | | (0.0202) | | |
| DcombCocina2 | | .012703 | .078877 | |
| | | (0.0223) | (0.1291) | |
| DcombCocina3 | | -.013896 | .24407 | |
| | | (0.0431) | (0.1555) | |
| DcombCocina4 | | .37804*** | | |
| | | (0.0517) | | |
| tanqAgua_arr | | -.018931 | .21515*** | |
| | | (0.0226) | (0.0754) | |

Table A8. *OLS estimation of Hedonic Price Function with spatial fixed effects (continued)*

| | (1)<br>All | (2)<br>Apart. | (3)<br>House in Condos | (4)<br>House no Condos |
|---|---|---|---|---|
| conjunCerr_arr | | .034201 | | |
| | | (0.0257) | | |
| DcombCocina2_arr | | .021562 | .13669 | |
| | | (0.0306) | (0.1649) | |
| DcombCocina3_arr | | -.0707 | -.13712 | |
| | | (0.0523) | (0.1806) | |
| DcombCocina4_arr | | -.56338*** | | |
| | | (0.1249) | | |
| lavadero | | | -.1094 | |
| | | | (0.0918) | |
| lavadero_arr | | | .11454 | |
| | | | (0.1059) | |
| garaje_arr | | | | .19606*** |
| | | | | (0.0437) |
| Constant | 4.2851*** | 4.2016*** | 5.4872*** | 4.7775*** |
| | (0.4039) | (0.4867) | (0.4977) | (0.3469) |
| $R^2$ | .67091 | .7262 | .73803 | .56368 |
| N | 6,061 | 4,153 | 319 | 1,562 |
| Est. Var. | cluster | cluster | cluster | cluster |

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A9. *Hedonic Price Function estimation with different functional form and different air quality variables*

| | Mean daily PM10 interpolated by VNA | | Mean daily PM10 interpolated by IDW | | Mean Dailly Maximum | |
|---|---|---|---|---|---|---|
| | Log-Lin | Log-Log | Log-Lin | Log-Log | Log-Lin | Log-Log |
| All | -0.01537 | -0.86020 | -0.00914 | -0.41898 | -0.00303 | -0.72675 |
| | (0.00000) | (0.00000) | (0.00189) | (0.00681) | (0.00021) | (0.00033) |
| Apart | -0.00612 | -0.30677 | -0.00187 | -0.04345 | -0.00081 | -0.11974 |
| | (0.03449) | (0.04848) | (0.51649) | (0.76441) | (0.39885) | (0.60767) |
| House in Condos | -0.02764 | 0.49005 | -0.05101 | 0.38448 | -0.00830 | 0.75956 |
| | (0.25870) | (0.47102) | (0.00206) | (0.57686) | (0.10124) | (0.48149) |
| House no Condos | -0.02165 | -0.48458 | -0.02299 | -0.67507 | -0.00812 | -1.03388 |
| | (0.00051) | (0.42851) | (0.00319) | (0.28500) | (0.00007) | (0.29131) |

P-value of individual significance test in parentheses

Table A10. *Demand for Air Quality Estimation using Log-Log Function*

| | (1)<br>First Stage | (2)<br>Second Stage |
|---|---|---|
| log(PM10) | | -.5232*** |
| | | (0.1296) |
| log(Rainfall) | -.0012634 | |
| | (0.0021) | |
| log(wind speed) | .006998** | |
| | (0.0034) | |
| log(WPM10) | 1.009*** | |
| | (0.0057) | |
| Income | -1.75e-07 | .0000274*** |
| | (0.0000) | (0.0000) |
| $R^2$ | | 0.400 |
| N | 5,693 | 5,693 |
| Hausman pValue | | 0.189 |
| Relevance pValue | | 0.000 |
| Hansen pValue | | 0.177 |
| Var. Est. | robust cluster | robust cluster |

Standard errors in parentheses
** $p < 0.05$, *** $p < 0.01$

Table A11. *Demand for Air Quality Estimation using IDW interpolation*

| | (1)<br>First Stage | (2)<br>Second Stage |
|---|---|---|
| meanStock | | -.074849** |
| | | (0.0295) |
| Rainfall | .010088** | |
| | (0.0041) | |
| Wind speed | 48.459*** | |
| | (13.6817) | |
| Wind speed² | -21.376*** | |
| | (6.9379) | |
| Wind speed³ | 3.0544*** | |
| | (1.1381) | |
| WPM10 | .94512*** | |
| | (0.0219) | |
| Income | -2.85e-06 | .0001252 |
| | (0.0000) | (0.0001) |
| $R^2$ | | 0.177 |
| N | 5,694 | 5,694 |
| Hausman pValor | | 0.153 |
| Relevancia pValor | | 0.000 |
| Hansen pValor | | 0.327 |
| Var. Est. | robust cluster | robust cluster |

Standard errors in parentheses
** $p < 0.05$, *** $p < 0.01$

Table A12. *Demand for Air Quality Estimation using like instruments Wind Speed, Wind Speed $^2$ and Wind Speed$^3$ and Winter mean of PM10*

| | (1)<br>First Stage | (2)<br>Second Stage |
|---|---|---|
| PM10 | | -.057278*** |
| | | (0.0132) |
| Wind speed | 16.535** | |
| | (6.6133) | |
| Wind speed² | -7.9354** | |
| | (3.4826) | |
| Wind speed³ | 1.2422** | |
| | (0.5852) | |
| WPM10 | 1.0106*** | |
| | (0.0146) | |
| Incone | -5.36e-06 | .0001854*** |
| | (0.0000) | (0.0001) |
| $R^2$ | | 0.279 |
| N | 5,694 | 5,694 |
| Hausman pValue | | 0.016 |
| Relevance pValue | | 0.000 |
| Hansen pValue | | 0.708 |
| Var. Est. | robust cluster | robust cluster |

Standard errors in parentheses
** $p < 0.05$, *** $p < 0.01$

Table A13. *Demand for Air Quality Estimation using like instruments Wind Speed, Wind Speed $^2$ and Wind Speed$^3$*

| | (1)<br>First Stage | (2)<br>Second Stage |
|---|---|---|
| PM10 | | -.072883** |
| | | (0.0310) |
| Wind speed | -442.35*** | |
| | (38.0815) | |
| Wind speed² | 235.76*** | |
| | (19.6906) | |
| Wind speed³ | -39.694*** | |
| | (3.3036) | |
| Incone | .0000392 | .0001849*** |
| | (0.0000) | (0.0001) |
| $R^2$ | | 0.279 |
| N | 5,694 | 5,694 |
| Hausman pValue | | 0.451 |
| Relevance pValue | | 0.000 |
| Hansen pValue | | 0.603 |
| Var. Est. | robust cluster | robust cluster |

Standard errors in parentheses
** $p < 0.05$, *** $p < 0.01$

Table A14. *Demand for Air Quality Estimation using FS estimation with localities*

| | (1)<br>First Stage | (2)<br>Second Stage |
|---|---|---|
| PM10 | | -.025757*** |
| | | (0.0054) |
| Rainfall | -.0057113** | |
| | (0.0026) | |
| Wind speed | 19.996*** | |
| | (5.9213) | |
| Wind speed² | -9.3602*** | |
| | (3.1687) | |
| Wind speed³ | 1.4206*** | |
| | (0.5423) | |
| WPM10 | 1.0011*** | |
| | (0.0176) | |
| Income | -5.03e-06 | .0001404*** |
| | (0.0000) | (0.0000) |
| $R^2$ | | 0.345 |
| N | 5,694 | 5,694 |
| Hausman pValue | | 0.030 |
| Relevance pValue | | 0.000 |
| Hansen pValue | | 0.305 |
| Var. Est. | robust cluster | robust cluster |

Standard errors in parentheses
** $p < 0.05$, *** $p < 0.01$

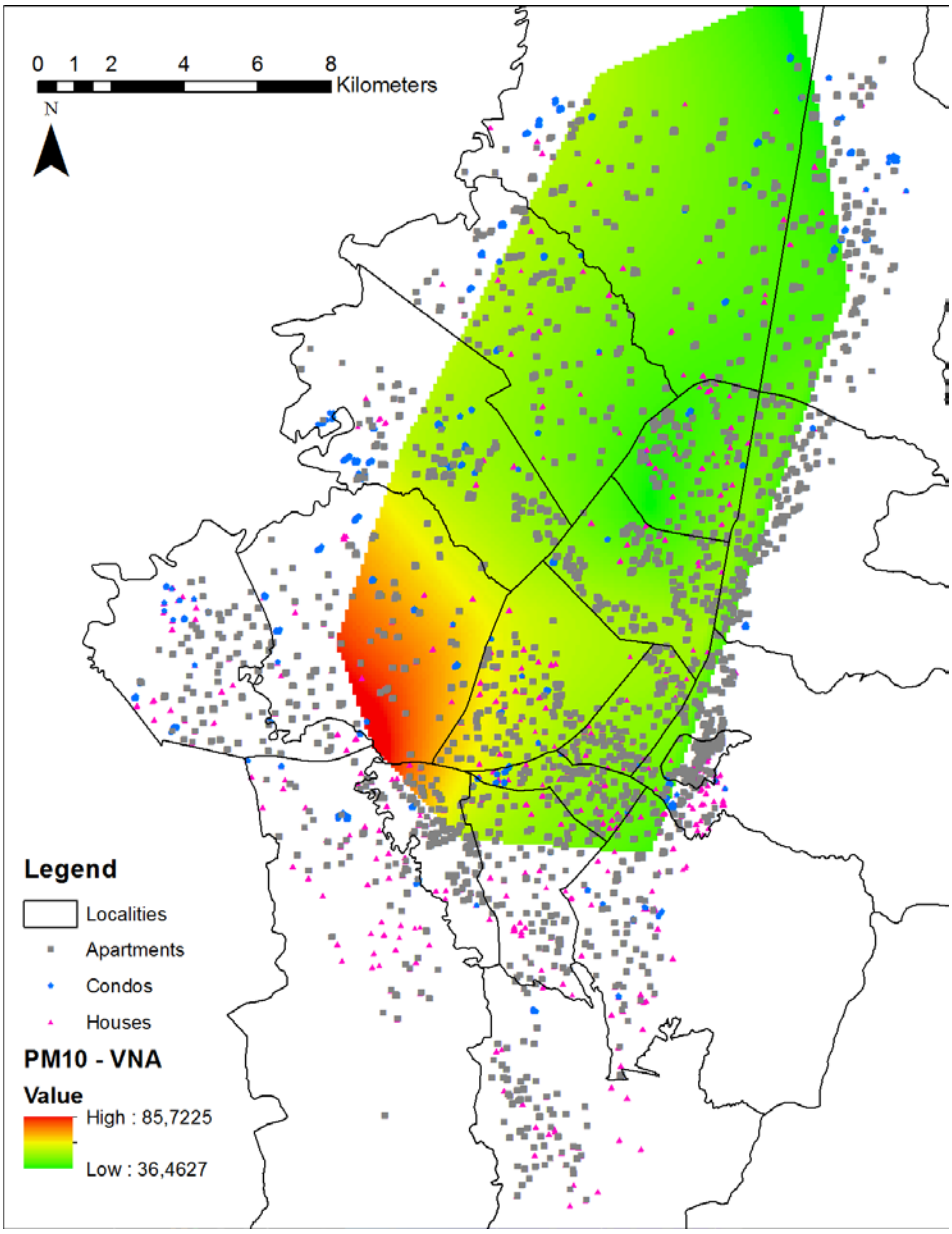


Figure A1. *Types of dwellings*

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