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Valuing complementarity between environmental goods and housing attributes with the benefit function: An application to flood hazards

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Selected Paper prepared for presentation for the 2016 Agricultural & Applied Economics Association, Boston, MA, July 31 - August 2

Abstract

This study proposes an approach to assess the monetary value of complementarity between environmental amenities and housing attributes with a benefit function approach. This novel approach serves as an extension of Rosen's (1974) two-stage hedonic model and makes both the identification and endogeneity problem tractable. The benefit function used in this paper was proposed by Luenberger (1992) and measures willingness-to-pay in number of units of a reference bundle, holding utility constant. Given that the benefit function is dual to the expenditure function, I am able to perform direct welfare analysis for non-marginal changes by recovering the parameters of the benefit function. Our approach is applied to valuing the complementarity between flooding hazards and residential property attributes in Centre County, Pennsylvania. The data set consists of parcel and housing transaction data in Centre County from 1990 to 2015 and flood hazard mapping data released by FEMA. The framework we develop is applicable to a wide range of commonly valued non-market goods and land use issues.

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1. Motivation and Research Questions

Complementarity among housing attributes in hedonic price model has long been recognized, for example, Witte et al. (1979) found a pattern of complementarity in consumption among house quality, dwelling size and lot size, but few studies since then have investigated this complementarity issue. Complementarity between environmental goods and housing attributes are common. For instance, an owner who has a house with a spacious porch or backyard might place higher value on good air quality because she would spend more time outside; and this relation also works reversely, i.e., people live or look for houses in an area with clean air would possibly place higher value on a porch and backyard. Another example, on one hand a reduction in flooding frequency could give an owner higher benefit if her house has a basement, and, on the other hand, higher flooding risk in a neighborhood could deteriorate the value of a basement. Among a large body of literature on the effects of air quality on property values, several studies have estimated the demand for air quality using Rosen's two-stage hedonic price model such as Brasington and Hite (2005), Chattopadhyay (1999), and Zabel and Kiel (2000). The impacts of flood hazards on housing market have been frequently examined by hedonic price approach as well, for example, Harrison et al. 2002 and Bin and Polasky (2004). However, the complementarity between environmental amenities and housing attributes has rarely been addressed under the framework of hedonic price model yet.

In this article, we not only investigate the complementarity between environmental amenities and housing attributes filling this gap in the literature, but also assess the monetary value of this complementarity using a benefit function approach. The benefit function, as developed by Luenberger (1992), provides a measure of willingness-to-pay expressed in number of units of a reference bundle, holding utility constant. There are two features of the benefit function that make it an ideal tool to measure the value of complementarity between environmental amenities

and housing attributes. First, Luenberger (1996) suggested that benefit function is favorable for valuing public goods as it is a welfare measure in quantity and utility space only, and the primal setting makes the interpretation of welfare more straightforward. The benefit function has not yet, however, been implemented in any non-market valuation study from demand prospective.¹ Second, the aggregate benefit is simply the sum of individual benefits across consumers and the Hessian matrix of individual benefit function can be aggregated thus allowing the benefit function to be used to value complementarity. These two characteristics of the benefit function allow us to derive demand functions of environmental goods and housing attributes using implicit prices from a first-stage hedonic price function. The welfare effects of non-marginal changes in the provision of environmental goods thus can also be evaluated.

One of the reasons for few hedonic price studies focusing on the complementarity between housing attributes and environmental goods can be traced to the difficulty in estimating the marginal bid functions (or demand functions) of housing attributes. The classical work of Rosen (1974) built the theoretical foundation of the hedonic price model, and since then the hedonic price model has been one of the most dominant methods to study housing market and valuing local public goods. His two-stage approach allows the marginal bid function, or the marginal willingness-to-pay function, to be derived, and thus it is able to value non-marginal changes in the provision of goods. Given the fact that housing attributes normally cannot be arbitrarily unbundled, a nonlinear first stage hedonic price function should be used for most of the cases. The nonlinear hedonic price function, however, leads to the identification and endogeneity issues in the second stage estimation,² and many remedies for these two issues largely increase the data

¹ A few studies have applied the directional distance function, the production analogue to benefit function, to assess the value of non-market goods in terms of the value they generate, for example, Bostian and Herlihy (2012) and Zago (2009).

² In short, the endogeneity issue is that the implicit price of an attribute is simultaneously chosen with the quantity

needed to achieve the estimation. An alternative instrumental variable approach was proposed by Bartik (1987), which requires data from multiple markets and variables that exogenously shift the household budget constraints, although this IV approach suffers from few natural exclusion restrictions available due to the market equilibrium nature of the hedonic model. Ekeland et al. (2004) proposed a nonparametric-based IV approach to recover marginal willingness-to-pay which can be used with data from single market. They showed that the conditional expectation of housing attributes given buyers/sellers characteristics could be used as IVs for housing attributes. Bishop and Timmins (2015) implemented a likelihood-based estimation procedure which is closely related to the non-parametric approach developed in Ekeland et al. (2004). They essentially achieve identification by rewriting the demand functions as functions of individual characteristics. Despite these advances, estimating the marginal bid function is still an ongoing discussion, and many housing related hedonic price studies only focus on the first-stage estimation and derive the implicit prices of attributes and value marginal changes.

We exploit a benefit-function-based demand system model to achieve the identification for demands of environmental goods and housing attributes. Built upon Rosen's framework, a few studies have used almost ideal demand system (AIDS) model to analyze the demand for housing attributes (Parson, 1986, Garcia and Raya, 2011). Specifically, they estimated hedonic price functions of housing attributes and used the implicit prices obtained into the subsequent demand functions. The AIDS model implies that the prices are taken to be exogenous, but this setting can be inappropriate when we want to value environmental good and its quantity change associated with related policies, given that its quantity is exogenously determined. The inverse AIDS model has been developed by Eales and Unnevehr (1994) to work in applications where predetermined

consumed when the hedonic price function is nonlinear. See Palmquist (2005) for a review on these two econometric issues.

quantities are assumed, such as demand analysis of perishable goods (Eales et al. 1997; Beach and Holt, 2001). Quantity-based approaches are appropriate for analyzing the welfare effects when quantities of goods are predetermined and prices adjust accordingly to achieve market clearing (Kim, 1997). Therefore, we adopt an inverse demand system closely related to the inverse AIDS model to study the demands of environmental goods and associated housing attributes. The endogeneity issue between price and quantity was not addressed by Parson (1986) and Garcia and Raya (2011) as they used linear hedonic price functions, which imply that households can break up a property into parts and repackage the housing attributes to enjoy the benefits from each separate characteristics. We use a non-linear hedonic price function, and treat the companionate endogeneity problem by strategy proposed in Bishop and Timmins (2015), which does not require IV in estimating marginal willingness to pay functions.

Empirically, we apply this approach to study the complementarity between flooding hazards and residential housing attributes in Centre County, Pennsylvania, although our approach can be applied to a wide range of commonly valued non-market goods and land use issues such as open space development. In terms of the housing attributes that might be complement with (no) flood hazards, in this study we focus on one attribute that is prone to be affected by flood: basement, both finished and unfinished. Our preliminary findings show that locating in flood zone does not necessarily decrease property value, while the negative impact only exists when a property has finished basement.

2. Method

In this section, first we present the benefit function and the framework of our approach, and the data set used for application is described in section 2.2. In section 2.3, we then illustrate the empirical model, building on benefit function, for estimating the inverse demand functions. The strategies for achieving identification and solving endogeneity issue in the Rosen's second stage hedonic price estimation are discussed. Given the demonstration of benefit function, the complementarity valuation approach is then presented.

2.1. Benefit Function and Approach for Valuing Complementarity

Consider a household preference being represented by a utility function $u(\mathbf{x})$, which is quasi-concave and continuous, and where \mathbf{x} is the vector of housing attributes and associated environmental goods. Let \mathbf{g} to be the vector of reference bundle, in the same dimension of \mathbf{x} , Luenberger's benefit function can be defined as

$$b(\mathbf{x}, U) = \begin{cases} \max\{\beta: u(\mathbf{x} - \beta\mathbf{g}) \geq U, \mathbf{x} - \beta\mathbf{g} \in X\}, & \text{if } u(\mathbf{x} - \beta\mathbf{g}) \geq U \text{ and } \mathbf{x} - \beta\mathbf{g} \in X \text{ for some } \beta \\ -\infty, & \text{otherwise} \end{cases}$$

This function shows the maximum number (β) of unit of \mathbf{g} a household being willing to pay to move from a given utility level U to the new consumption bundle \mathbf{x} , so it follows that the marginal benefit with respect to \mathbf{x} is a measure of the marginal willingness to pay for \mathbf{x} . Figure 1 illustrates the definition of the benefit function. In this two-dimensional case, we want to find the greatest β that makes $\mathbf{x} - \beta\mathbf{g}$ just above the indifference curve representing utility level U . That maximum number of β is $b(\mathbf{x}, U)$. Some important characteristics of the benefit function are, (1) $u(\mathbf{x}) = U$ implies that $b(\mathbf{x}, U) = 0$, i.e., $b(\mathbf{x}, U) = 0$ is an implicit representation of household preference; and (2) if $u(\mathbf{x})$ is quasi-concave with respect to \mathbf{x} , then $b(\mathbf{x}, U)$ is concave with respect to \mathbf{x} .

This also implies that, if $b(\mathbf{x}, U)$ is twice differentiable in \mathbf{x} , $\partial^2 b / \partial \mathbf{x} \partial \mathbf{x}^T$ is symmetric and negative semi-definite. See Luenberger (1995) for a complete presentation of benefit function.

Given a specific form of the benefit function, the inverse demand, also the marginal benefit function, of \mathbf{x} can then be derived by differentiating $b(\mathbf{x}, U)$ with respect to \mathbf{x} . We use the implicit prices derived from the first-stage hedonic regression as the left-hand side variable in our empirical model for the inverse demand. That is, we equate the marginal prices with the marginal benefit function in our second-stage analysis, instead of equating the marginal implicit prices with Rosen's bid function. The estimation results of the inverse demand functions can then be used to recover the benefit functions. Finally, we adopt the strategy proposed by Baggio and Chavas (2009), which will be illustrated in section 2.3.3, to assess the monetary value of complementarity between housing attributes and flood hazards.

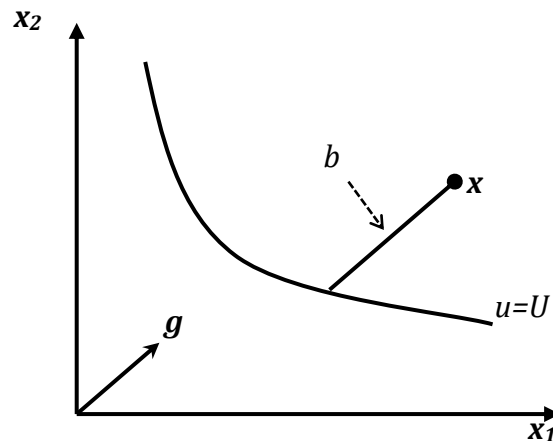


Figure 1 The benefit function

2.2. Data

Our approach is applied to study the complementarity between flooding hazards and residential housing attributes in Centre County, Pennsylvania. We have the parcel data including detailed housing characteristics and the historical transaction records from 1882 – 2015, both provided by the Tax Assessment Office of Centre County.³ We limit our sample to residential properties with lot sizes less than 10 acres, and further exclude fraternities, seasonal properties, mobile homes, and properties with some commercial function. In order to limit preference changes over time, we cut the transaction records before year 1990. These selection criteria leave us 30,819 parcels with 67,819 transaction records in total.⁴

The digital flood insurance rate map of Centre County was downloaded from the Federal Emergency Management Agency (FEMA). The GIS office in Centre County also shared parcel and street layer GIS data so that we are able to identify if a property sits on a flood plain and calculate the distance to the Penn State campus and the nearest grocery store from each property. Among the 30,819 parcels that we select, 1,922 are inside a flood zone.⁵ Finally, the Centre County Recorder of Deeds Office kindly offered the mortgage records with names of the borrower and lender, loan amount, and document date available. We are then able to match these records to those provided in Home Mortgage Disclosure Act (HMDA) data following the strategy proposed in Bayer et al. (2015), and some demographic information of home buyers, such as income and race, will be available to us. The HMDA data was downloaded via Federal Financial Institutions Examination Council's (FFIEC) web site.

³ All prices are indexed to 3rd quarter, 2015, using the quarterly all-transaction house price index of State College metropolitan statistical area provided by Federal Housing Financial Agency.

⁴ 83.72% of these 30,819 parcels have multiple transaction records with an average number of transactions of 3.51.

⁵ A flood zone is, based on FEMA's definition, the area subject to flooding by the 1% annual chance flood.

2.3. Empirical Model

2.3.1. First-stage Hedonic Price Model

A hedonic price function is a reduced-form function revealing both housing supply and demand, and normally the appropriate functional form cannot be specified on a theoretical ground (Halvorsen and Pollakowski, 1981). With a cross-sectional housing data, Halvorsen and Pollakowski (1981) suggests that a quadratic Box-Cox form is the most appropriate specification for hedonic price function, as it is a very general form which actually yields many other forms, such as, linear, semilog, translog, quadratic, Leontif, as special cases. However, the comment from Cassel and Mendelsohn (1985) pointed out that a flexible Box-Cox form does not necessarily produce more accurate estimates and also lead to poorer prediction. That comment is later partially confirmed by Cropper et al. (1988). Cropper et al. conducted a comprehensive simulation with translog and Diewart form utilities. Their results show that, when all attributes are observed, a linear or quadratic Box-Cox hedonic price function outperforms others in terms of errors in measuring marginal prices. While a linear or linear Box-Cox perform the best when some attributes are unobserved or are replaced by proxies. Later, Rasmussen and Zuehkle (1990) suggests that a quadratic semilog form performs better than a linear Box-Cox form in term of explanatory power and in the meantime is preferred than a quadratic Box-Cox form due to the easiness of interpretation with minor loss in explanatory power.

In light of the findings of Rasmussen and Zuehkle (1990), we use a quadratic semi-log specification for the first-stage hedonic price function which as the following:

$$\ln(P_{ijt}) = \alpha + \beta'X_{ij} + 0.5X_{ij}'\beta X_{ij} + h_{ij} + \mu_t + v_{jt} + \varepsilon_{ijt} \quad (1)$$

P_{ijt} is a matrix of the adjusted sale price of property i in census tract (or municipality) j at time t .

X_{ij} is a matrix of the time- and spatially-invariant housing characteristics which include lot size on

deed, lot size not occupied by building,⁶ living area, year built, garage area, number of rooms, bedrooms, bathrooms, half-bathrooms, fireplaces, if the property has public water or a sewer connection, central air condition, pool, property's exterior material, basement area, finished basement area, if a property sits in flood zone, and the travel time to Penn State campus and the nearest grocery store. h_{ij} is a vector of parcel-specific unobserved heterogeneity, such as scenic views, balcony, porch, deck, floor material, and outbuildings. μ_t is a vector of time-varying unobserved factors for the entire market in Centre county,⁷ and v_{jt} is a vector of unobserved heterogeneity across census tracts (or municipalities) and time. ε_{ijt} is an IID error term for all other unobservable factors.

2.3.2. Benefit Function and Inverse Demands

Adopting the framework of Baggio and Chavas (2009), who value the complementarity in an Italian fish market, we estimate an inverse demand system of housing attributes and environmental goods, where the inverse demands are derived under a specific form of benefit function which is given by

$$b(\mathbf{x}, U) = \alpha(\mathbf{x}) - [U\beta(\mathbf{x})]/[1 - U\gamma(\mathbf{x})] \quad (2)$$

Note that \mathbf{x} is the vector of housing attributes and associated environmental goods.

This specification is an analogue of the distance function specified for inverse AIDS model in Eales and Unnevehr (1994). The inverse demand of good/attribute i can then be derived by differentiating $b(\mathbf{x}, U)$ with respect to \mathbf{x} , which yields

$$p_i(\mathbf{x}) = \alpha_i + \sum_{j=1}^M \alpha_{ij} x_j - \beta_i \alpha(\mathbf{x}) - \gamma_i \alpha(\mathbf{x})^2 / \beta(\mathbf{x}), \quad (3)$$

⁶ We use this variable as a proxy of yard size, which is calculated by subtracting the area occupied by building from the lot size on map in GIS.

⁷ Given the enough observation of our data, we control for both yearly and quarterly fixed effects.

where

$$\alpha(\mathbf{x}) = \sum_{i=1}^M \alpha_i x_i + 0.5 \sum_{i=1}^M \sum_{j=1}^M \alpha_{ij} x_i x_j, \beta(\mathbf{x}) = \exp(\sum_{i=1}^M \beta_i x_i), \text{ and } \gamma(\mathbf{x}) = \sum_{i=1}^M \gamma_i x_i$$

Note that $p_i(\mathbf{x}) = \partial b(\mathbf{x}, U) / \partial x_i$ is the “adjusted price function” in Luenberger’s terminology. See Baggio and Chavas (2009) for detailed derivation of the inverse demand function above and the restrictions on parameters.

Parson (1986) and Garcia and Raya (2011) applied the AIDS model to estimate demand functions of housing attributes with implicit prices derived from the first-stage price function. Using a similar approach, the empirical model for the inverse demand of good/attribute i is

$$\check{p}_i(\mathbf{x}) = \alpha_i + \sum_{j=1}^M \alpha_{ij} x_j - \beta_i \alpha(\mathbf{x}) - \gamma_i \alpha(\mathbf{x})^2 / \beta(\mathbf{x}) + \sum_{k=1}^K \delta_k c_k + \varepsilon_i, \quad (4)$$

where \check{p}_i are the implicit prices of good/attribute i estimated through the hedonic price function, i.e. equation (1), c_k are demand shifters such as owner characteristics, and ε_i is a disturbance term follows $N(0, \sigma^2)$. The estimation results of the demand functions, i.e., estimates of $\alpha(\mathbf{x})$, $\beta(\mathbf{x})$, and $\gamma(\mathbf{x})$, can be used to recover the benefit functions.

As reviewed in the introduction, using a nonlinear (in variable) first-stage hedonic function is appropriate given the fact that many housing attributes cannot arbitrarily be repackaged, and this will inevitably lead to the problems of identification and endogeneity. Brown and Rosen (1982) suggest that the identification in the second-stage hedonic price estimation can be achieved in a single market with restrictions on parameters. Hence, in our setting, the identification is achieved with the restrictions imposed for an inverse AIDS model. In terms of the endogeneity problem, we adopt the strategy proposed by Bishop and Timmins (2015). The procedure in essence rewrites the demand of environmental goods and housing attributes as functions of individual characteristics and unobserved taste shifters, instead of equating the implicit prices of amenities to

the marginal benefits, which is a function of the quantity of amenities, as in the traditional Rosen's second-stage estimation.

2.3.3. Valuing Complementarity

Typically we can use a second stage hedonic model to study the welfare change based on the Slutsky matrix, but the analysis is only for a (representative) individual's demand characteristics. The benefit function allows us to measure second order effects on benefits by aggregating individual Hessian matrix and thus valuing complementarity,⁸ while the Slutsky matrix is not useful in this case since it is derived from an individualized normalizing condition, $p \cdot x = 1$ (Luenberger, 1996). With some modifications on the strategy proposed by Baggio and Chavas (2009), below we illustrate how the value of complementarity between environmental attributes (being located in a flood zone) and housing characteristics (having a basement) is calculated.

Denoting the vector of environmental goods as x_E and that of housing attributes as x_H , the marginal willingness to pay (w) for a quantity change in environmental goods from x_E^0 to x_E^1 can be expressed by benefit function as

$$w(x_E, x_H, U) = b(x_E^1, x_H, U) - b(x_E^0, x_H, U) \quad (5)$$

The above expression is analogous to the definition of compensating variation. We then further separate the housing attributes into complement attributes (x_{Hc}) and non-complement attributes (x_{Hn}) with environmental goods, and the value of complementarity can be written as

$$w_c(x, U) = \sum_{k=1}^K w_k(x, U) + w_e(x, U) - w_a(x, U), \quad (6)$$

where

⁸ Chavas and Baggio (2011) applied a similar framework to value consumption diversity.

$$w_a(x, U) = b(x_E, x_{Hc}, x_{Hn}, U) - b(0, 0, x_{Hn}, U)$$

$$w_e(x, U) = b(x_E, x_{Hc}, x_{Hn}, U) - b(0, x_{Hc}, x_{Hn}, U)$$

$$w_k(x, U) = b(x_E, x_{Hc}^k, x_{Hc}^{k'}, x_{Hn}, U) - b(x_E, 0, x_{Hc}^{k'}, x_{Hn}, U)$$

Note that x_{Hc}^k is the k^{th} element in x_{Hc} , while $x_{Hc}^{k'}$ is all elements in x_{Hc} except x_{Hc}^k . w_k is the incremental value when a complement attribute x_{Hc}^k presents, given the quantities of all other attributes. This value includes not only the value solely came from the provision of x_{Hc}^k but also the value generated from the complementary. Similarly, w_e is the incremental value when the environmental goods are provided. Again, the value consists of both the value of the provision of x_E and the value of complementarity. The sum of the first two terms in equation (6) therefore gives us the individual values of environmental goods and all complement attributes and twice the value of complementarity. And, finally, the value of complementarity can be isolated by subtracting w_a from the sum of the first two terms, where w_a is the total value of environmental goods, complement attributes, and complementarity,

Since the value function of complementarity can be rewritten as a summation of various benefit functions, we can easily calculate the value once we have the benefit function in equation (1) recovered. A positive value of w_c will confirm the complementarity between x_E and x_{Hc} , while if w_c equals to zero, x_E and x_{Hc} are independent goods. If the value turns out to be negative, x_E and x_{Hc} are actually substitute goods.

3. Results

We ran two OLS models in order to test two crucial hypotheses which can give us a solid ground to push our study further: first, properties located in a flood zone are on averagely cheaper than other properties, and second, complementarity exists between located in a flood zone and having a (finished) basement. Note that, in searching for the appropriate specification of the first-stage hedonic price function, we find that the assessed value is well estimated by the marginal values of housing attributes included in section 2.3.1.⁹ Therefore, we use the assessed value with no basement value included¹⁰ as a proxy for all housing attributes except the possible complement attributes we are interested in. To control for some unnecessary heterogeneity, at this stage, we further limit our sample with the following criteria: (1) the most recent transaction, (2) arm-length transaction, (3) lot size no more than 1 acre, (4) basement area no more than 5,000 square foot, (5) adjusted sale price between \$50,000 and \$1,000,000. The first model regresses adjusted sale price on the assessed value without basement, basement area, finished basement area, the square terms of previous three variables, and a dummy variable indicating whether a property located in a flood zone. The second model includes two interactions terms between located in a flood zone and (finished) base area, in addition to the independent variables included in the first model. The regression results are shown in Table 1.

The coefficients of model 1 all have expected signs and are significant. It shows that, on average, located in a flood zone decreases the property value by \$13,177. Model 2 shows that, the factor that located in a flood zone alone does not significantly decrease the value of a property. However, the negative impact of flood hazards is revealed when a property has finished basement.

⁹ See Table A1 in the appendix for the regression result.

¹⁰ The assessed value with no basement value included is calculated by subtracting the assessed value by the value of finished basement, which is explicitly listed in tax assessment data and estimated value of basement area, i.e., the implicit assessed per Sq-Ft price of basement area times the basement area.

The findings confirm our hypotheses and grant a sound interpretation: people care about if a property sitting on a flood plain when that property has a finished basement.

In this study we will empirically explore the value of complementarity between selected environmental goods, flood hazard, and housing attributes. The results could have important policy implication on the welfare effects for different households resulting from a quantity or quality change in the provision of environmental goods. Additionally, we will demonstrate the implementation of an inverse demand system model based on Luenberger's benefit function on investigating the demand of housing attributes and associated environmental goods. The approach proposed in this study also serves as an alternative to Rosen's two-stage hedonic model, which makes the identification problem to be tractable with imposed parameter restrictions on demand function.

Table 1 Regression Results for Adjusted Sale Price

Variable	Model 1			Model 2		
	Coeff.	Std. Err.		Coeff.	Std. Err.	
Assessed Value (Dollar)	1.924626	0.026218	***	1.930582	0.026185	***
(Assessed Value) ²	-1.26E-06	7.69E-08	***	-1.28E-06	7.68E-08	***
Basement Area (SqFt)	17.71193	1.480801	***	17.73491	1.480364	***
(Basement Area) ²	-0.0048741	0.000479	***	-0.0048412	0.0004783	***
Finished Basement Area (SqFt)	51.52484	4.098743	***	53.22581	4.101959	***
(Finished Basement Area) ²	-0.0240872	0.00345	***	-0.0242851	0.0034437	***
Flood Zone (Yes = 1, No = 0)	-13177.64	2820.415	***	-2138.219	4839.707	
Basement * Flood Zone				-4.026485	2.995177	
Finished Basement * Flood Zone				-73.7578	11.95772	***
Constant	19346.82	2030.755	***	18538.46	2033.106	***
Number of Observation		12,344			12,344	
Adjusted R-Square		0.7273			0.7283	

***: P-value < 0.01

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Appendix

Table A1 Regression Result for Assessed Value

Variable	Coefficients	Std. Err.	P-Value
Lot Size on Deed (Acre)	29857.65	963.9319	0
Alpha Grade ¹	1210.535	10.74707	0
Time to PSU (Second)	0.07547	1.41831	0.958
Year Built	10.02322	3.552946	0.005
Living Area (SqFt)	47.60745	0.391481	0
Garage Size (SqFt)	14.54118	0.735872	0
Number of Cars in Garage	-2946.7	187.145	0
Number of Rooms	-1024.12	125.3775	0
Number of Bedrooms	-799.083	250.7915	0.001
Number of Full Bath	1614.553	319.4851	0
Number Half Bath	-1243.42	293.44	0
Public Sewer Connection ²	4842.07	776.9406	0
Public Water Connection ²	-101.536	830.4032	0.903
Number of Fireplace	116.1349	280.6615	0.679
Central AC ²	2148.494	557.1976	0
Remodeled ²	-341.949	565.872	0.546
Paved Street ²	1367.038	879.1997	0.12
Pool ²	-1685.15	859.86	0.05
Basement (%)	3.591825	0.173849	0
Finished Basement Area	23.79439	0.517366	0
Constant	-160717.4	17185.37	0.000
District Dummies		Yes	
Exterior Siding Dummies		Yes	
Heating System Dummies		Yes	
Number of Observations: 12344			
Adjusted R-Square: 0.9450			

Note 1: Alpha grade is a grade of a building's overall quality given by the assessor.

Note 2: Dummy Variable (Yes = 1, No = 0)