This article summarizes the modern “best practices” for using hedonic property value models to measure how much people are willing to pay for environmental amenities and other public goods.
Enduring Popularity of Hedonic Property Value Models

- Intuitive and economically rich premise
- Unifies structural and reduced form descriptions of how heterogeneous buyers and sellers trade differentiated goods
- Illustrates why markets work
- Empirically tractable
- Can help to inform consumers, firms, and policymakers

Enduring Popularity of Hedonic Property Value Models

Comprehensive and Technical Literature Reviews


Our Focus: Best Practices After the “Credibility Revolution”

- Higher expectations for transparency in data and econometrics
- More subtle mapping from identified parameters to welfare measures
Outline

1. The Hedonic Property Value Model in Pictures

2. Best Practices
   A. Defining the market
   B. Data collection
   C. Selecting an econometric specification
   D. Mitigating confounding factors
   E. Using estimates to inform policy

3. Conclusions and a Research Agenda

4. Supplemental Appendix (online in REEP’s archive)
   A. International summary of data sources
   B. Hedonic modeling with less-than-ideal data
The Hedonic Property Value Model in Pictures

- Bid function shape depends on wealth, preferences and information
The Hedonic Property Value Model in Pictures

- Offer function shape depends on technology and regulation.
The Hedonic Property Value Model in Pictures

House price

Amenity

P_1

P_2

A_1

A_2
The Hedonic Property Value Model in Pictures

The diagram illustrates the relationship between house price and amenity. The price function in year $S$ is depicted, with price points $P_1$ and $P_2$ corresponding to amenity levels $A_1$ and $A_2$. The model shows the interaction between bids $b_1$ and $b_2$ and offers $o_1$ and $o_2$, emphasizing the market dynamics in this context.
The Hedonic Property Value Model in Pictures

House price

Price function in year $S$

Amenity
The Hedonic Property Value Model in Pictures

House price

$P_1^A$  $P_2^A$

Amenity

$A_1$  $A_2$

Marginal price function in year $S$

demand$_1$  demand$_2$
The Hedonic Property Value Model in Pictures

Amenity

House price

\[ P_2^A \]

\[ P_1^A \]

Marginal price function in year S

\[ A_1 \]

\[ A_2 \]

demand₁

demand₂
The Hedonic Property Value Model in Pictures

Marginal price function in year T

Marginal price function in year S

demand_{2,T}

demand_{2,S}

demand_{1,S}

A_{1}

A_{2}

A_{3}

House price

P_{3}^{A}

P_{2}^{A}

P_{1}^{A}
Estimating Marginal Willingness to Pay (MWTP)

1. Estimate the equilibrium hedonic price function
2. Differentiate to obtain marginal price function
3. Evaluate for each buyer to recover MWTP
4. Use MWTP to inform policy
Best Practices: Defining the Market

**Best Practice:** a geographic area in which identical houses sell at the same price throughout the market so that the “law of one price function” holds (e.g. a single metropolitan area in a single year)

Challenges with larger geographic areas and longer time periods

- Larger areas may embed other frictions and margins of adjustment (e.g. moving cost, wages, taxes, cost-of-living)
- Longer time periods may embed changes in the price function (e.g. boom-bust cycles, regulation, information)

Econometric flexibility can address these challenges in pooled data
Best Practices: Data Collection

**Best Practice:** random sample of micro data on arm’s length property transactions, describing sale prices and how buyers perceive physical characteristics and amenity levels.

**Issues with other common data formats**

- Predicted prices (e.g. Census self-reports, appraisals) may introduce non-random measurement error that is correlated with buyer demographics, housing characteristics, and neighborhood amenities.

- Spatially aggregated data (e.g. means or medians) do not have a known mapping to hedonic equilibrium or a clear welfare interpretation.
**Best Practice:** random sample of micro data on arm’s length property transactions, describing sale prices and how buyers perceive physical characteristics and amenity levels.

**Potential issues to consider**

- Buyer beliefs are unknown and may be heterogenous
- Buyers may care about features of environmental quality not directly targeted by policy (e.g. water clarity versus ecosystem health)
- Beliefs may be based on past, present and/or future amenity levels (Bishop and Murphy, ReStat 2019)
**Best Practices: Econometrics**

**Best Practice** – allow for nonlinearity in the shape of the price function

- Functional form: flexibility improves accuracy
  - Nonstationary (Kuminoff and Pope IER 2014)

- Econometric errors
  - Heteroskedasticity and spatial correlation can be addressed by using robust standard errors and clustering.
Best Practices: Avoiding Confounding

**Best Practice** – document transparent exogenous variation in amenity

- Common identification strategies
  - spatial dummy variables (e.g. Von Gravenitz JEEM 2018)
  - matching (e.g. Walls et al. JEEM 2017)
  - discontinuity designs (e.g. Black QJE 1999)
  - instrumental variables (e.g. Chay and Greenstone JPE 2005)
  - difference-in-difference (e.g. Davis AER 2004)

- Econometric identification strategy conditions interpretation
  - spatial sample selection
  - price function changes
Example: Boundary Discontinuity Designs

- Control for endogenous amenities due to boundary sorting (Bayer et al. JPE 2007)
- Does not identify MWTP for people living outside boundary zones

Examples: school zones, flood zones, public water service areas, fire protection areas, etc.
Example: Capitalization and Price Function Changes

House price

Marginal price function in year T

Marginal price function in year S

$P^T_2$

$P^S_1$

Amenity

A1 → A2
Example: Capitalization and Price Function Changes

Kuminoff, Parmeter, and Pope (JEEM, 2010)
Kuminoff and Pope (IER, 2014)
Banzhaf (IER, 2020)
Banzhaf (JPE, forthcoming)

House price

$P^T_2$

$P^S_1$

Marginal price function in year $T$

Marginal price function in year $S$

Amenity

$A_1$ \rightarrow $A_2$
Using MWTP to Inform Policy: Demand Estimation

House price

$P_2^T$

Amenity

Marginal price function in year T

$\text{demand}_2$

$A_1 \rightarrow A_2$
Several strategies have been proposed to point-identify WTP by adding more data and assumptions about buyer preferences.

- **Examples**: Bartik (JPE 1987), Zabel and Kiel (Land 2000), Ekeland, Heckman and Nesheim (JPE 2004), Bajari and Benkard (JPE 2005), Zhang, Boyle and Kuminoff (JEEM 2015), Bishop and Timmins (JAERE 2018), Bishop and Timmins (JUE 2019), Banzhaf (IER 2020)

Relatively few applications and relatively little work on validation make it hard to identify “best practices”

Important area for further research
Opportunities to Advance Current Knowledge

• Test the validity of models for hedonic demand estimation (e.g. Keane and Wolpin IER 2007, Galiani et al. AER 2016)

• Leverage administrative data to analyze distributional implications of policies

• Investigate information frictions and beliefs
  – Throughout applied micro, there is growing evidence that heterogeneity in beliefs matters for revealed preference analysis and policy
  – If beliefs diverge from the analyst’s information, then revealed preference estimates for MWTP may diverge from welfare
Comments and suggestions welcome!

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