Hedonic Vices: Fixing Inferences About Willingness to Pay in Recent House-Value Studies

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Prepared for the annual conference of the
Society for Benefit-Cost Analysis, March 15-17, 2017

Hedonic Vices

- As everyone here knows, many location-based amenities, including school quality and clean air, are not directly traded in markets,
- So regressions of house values on these amenities, called **hedonic regressions**, provide a key tool for determining the benefits these amenities provide.
- What you may not know is that the large empirical literature on hedonics seems to have lost touch with the underlying theory.
- The result is a series of "**hedonic vices**," which are discussed by Phuong Nguyen-Hoang and me in the Summer 2016 issue of the *JBCA.*

The Rosen Framework

- Most housing hedonic studies draw on the elegant presentation in Rosen (*JPE*, Jan./Feb.1974), which distinguishes between
  - A household **bid function**, which is an iso-utility curve for a given amenity, z.
  - The observed price function or hedonic, which is the **envelope** of the underlying bid functions.
    - The **implicit price** of z is the derivative of the hedonic with respect to z.

The Rosen Framework, 2

- In Rosen, θ is a bid, z is a trait, u is utility, and p is price (=envelope). His famous picture is:

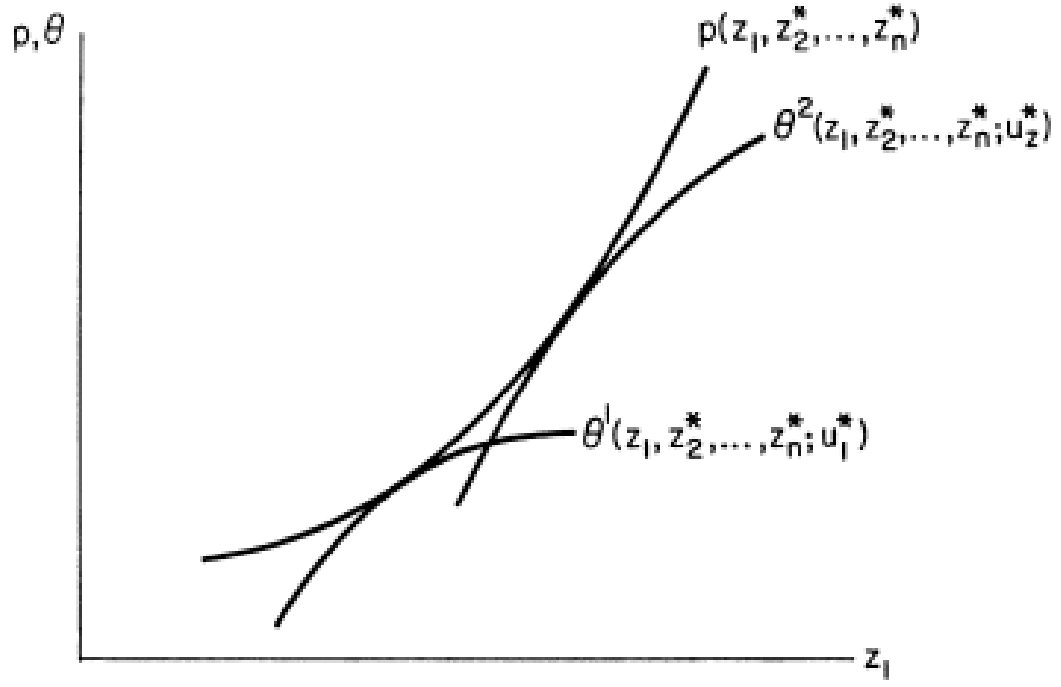


FIG. 1

The Rosen Framework, 3

- To obtain information on demand, Rosen recommends
  - (1) Estimating a general first-stage hedonic;
  - (2) Differentiating the hedonic to find the implicit prices;
  - (3) Estimating a second-stage demand (=bid) function with z on the left side and the implicit price on the right.
- As many scholars have pointed out, this approach is difficult to estimate because the implicit prices are endogenous; in selecting a value of z, a household also selects the implicit price.

Hedonic Vices: Specification A

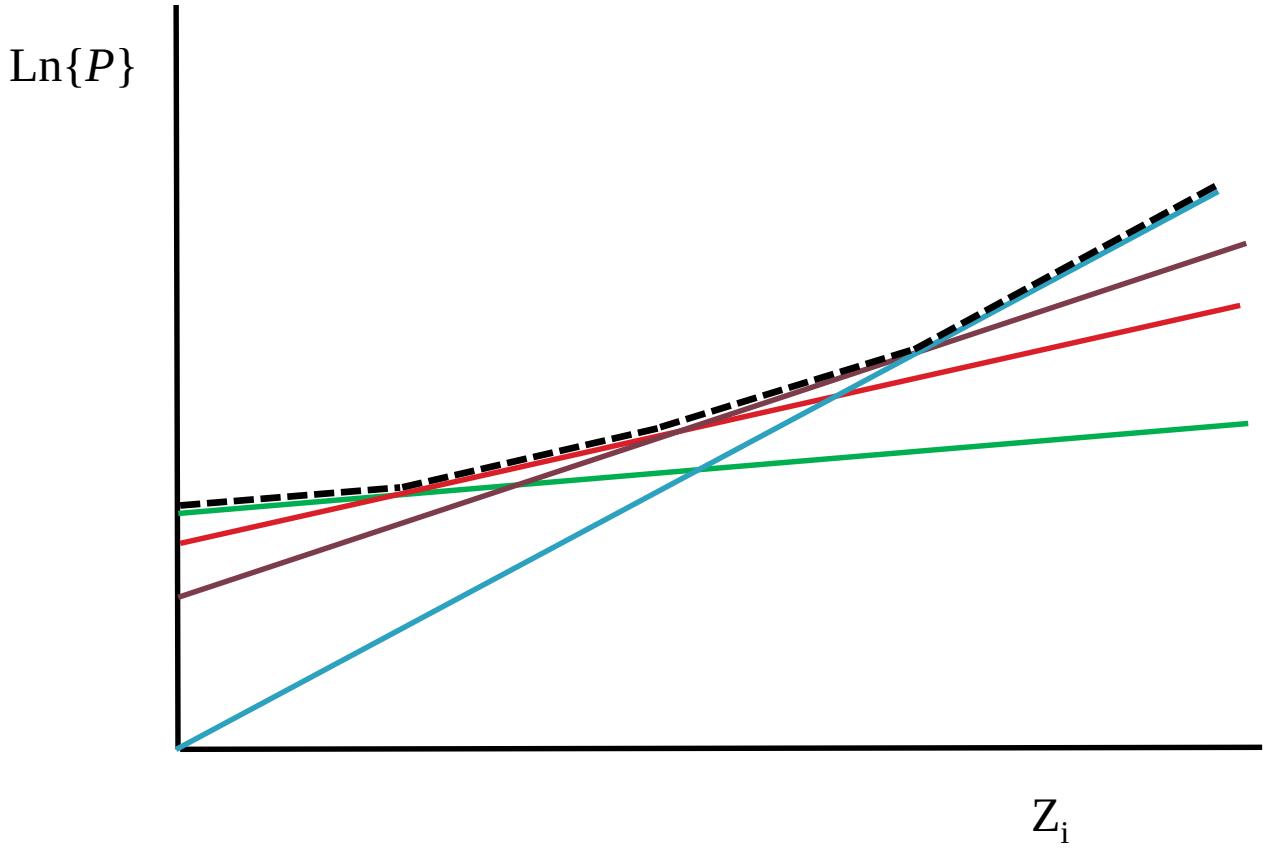
- Many studies regress house value (or log of house value) on a measure of the amenity (or its log).
- These one-variable hedonic specifications rule out sorting.
- That is, they rule out a key implication of the Rosen picture, namely, that households with a higher demand for the amenity win the competition for housing in places where the amenity is high.

Hedonic Vices: Specification A

- Take the simple case in which households have linear bid functions—i.e., bid functions with constant slopes—which correspond to a horizontal demand curve for the amenity.
  - As shown in the following figure, sorting arises when higher-demand households have steeper bid functions.
  - This sorting process implies that the slope of the hedonic rises with the amenity level.
  - If the hedonic is estimated with a constant slope, this sorting process is ruled out.

Hedonic Regressions

Hedonic Envelope with Linear Bid Functions



Hedonic Vices: Specification A, Continued

- Drawing on my recent article on hedonics (*JUE*, March 2015), we also show that other widely used functional forms are incompatible with sorting including:
  - Log-linear
  - Inverse
  - Box-Cox

Hedonic Vices: Specification B

- The hedonic specification may be inconsistent with the specification of the second-step demand functions.
  - With the assumptions in my *JUE* article, a quadratic envelope implies an infinite price elasticity of demand.
  - Estimating the price elasticity using implicit prices from a quadratic envelope is therefore inconsistent.

Hedonic Vices: Control Variables

- **Hedonic envelopes should not include demand variables.**
- Including demand variables turns the regression into a bid-function regression.
  - A bid function regression must deal with the fundamental endogeneity between prices and amenities.
  - A bid function regression must interact demand variables with amenities—or else everyone has the same bid-function slope and there is no sorting!

Hedonic Vices: Control Variables, 2

- Income is a key demand variable.
- Small-area income is highly correlated with individual income, especially individual permanent income.
- Using small-area income therefore changes the hedonic regression into a bid-function regression.
- This problem appears to arise using block-group income, but may not be serious for larger geographic units such as census tracts.

Hedonic Vices: Control Variables, 4

- One cannot avoid this problem by arguing that neighborhood-level demand traits, such as resident income and education, are neighborhood amenities.
- If these demand traits can be observed, they might, indeed, be viewed as amenities by house buyers.
- But this does not alter the fact that including them changes the meaning of the regression.

Hedonic Vices: Control Variables, 5

- This leaves researchers with three choices:
  - Leave out these demand traits and estimate a (possibly biased) hedonic regression
  - Include these traits, treat them as endogenous, interact them with amenities, and interpret the regression as a bid-function regression—not a hedonic.
  - Find exogenous measures of neighborhood amenities, such as the presence of public housing, parks, or golf courses, that may be correlated with income but are poor proxies for demand traits.

Hedonic Vices: Control Variables, 6

- This following chart illustrates these choices using data from Cleveland in 2000.
  - The regression with “observable amenities” estimates a quadratic with a long list of neighborhood variables.
  - The “parsimonious” regression drops secondary amenities.
  - The “demand variable” regression adds block group income and education variables.
  - The “bid function” regression adds the demand variables and interacts income with the school quality variable.
- We also support these points (and others) with a simulation model.

Hedonic Regressions

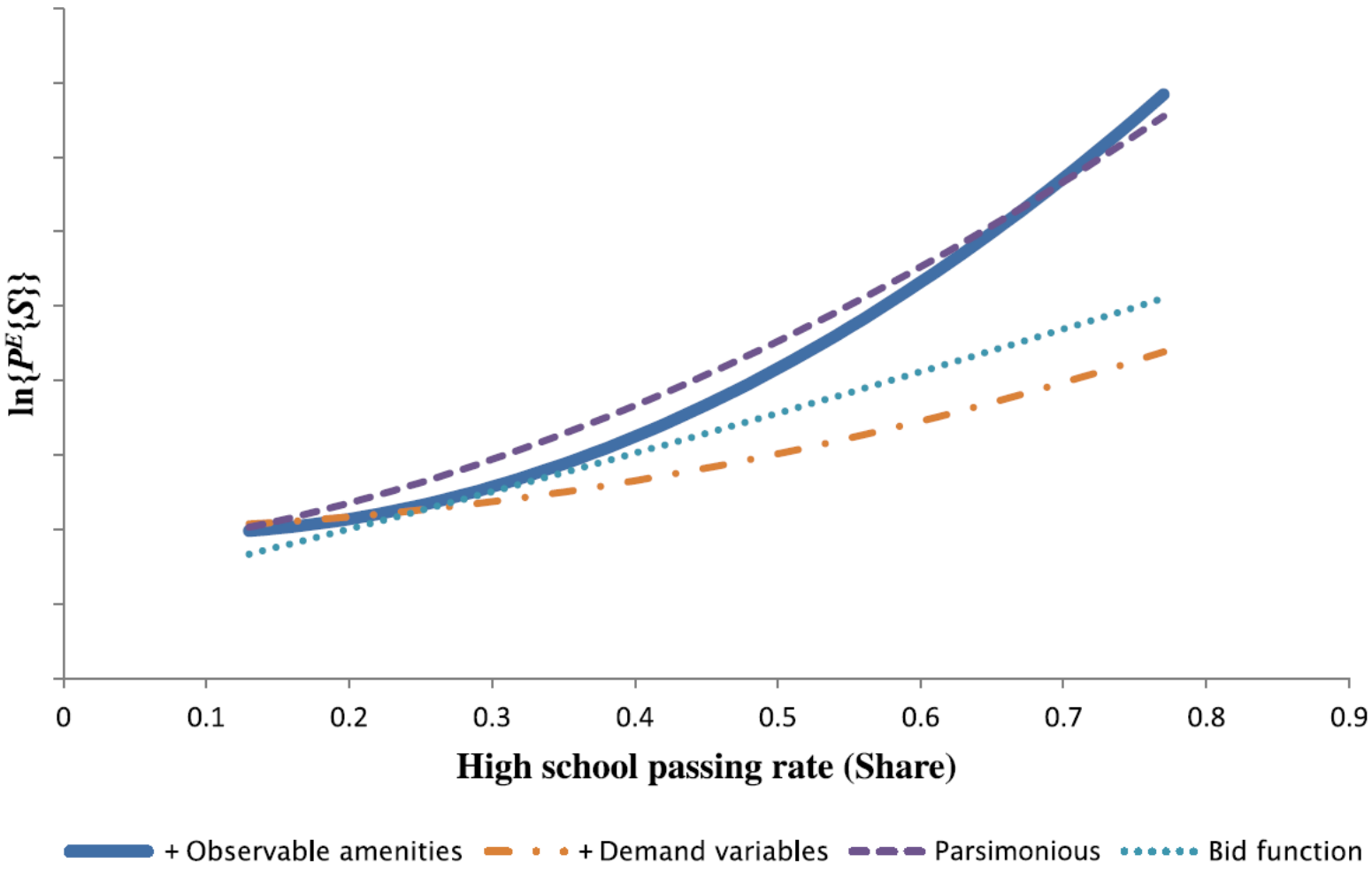


Figure 3 Comparison of alternative specifications, high-school passing rate.

Control Variable Vices

Hedonic Vices: Interpretation, A

- A properly specified hedonic yields average MWTP.
  - But this only applies to an equal marginal change at all levels of the amenity starting from the current equilibrium.
- Hence, this estimate does not apply to any reasonable policy simulation.

Hedonic Vices: Interpretation, B

- Some studies compare the mean MWTP from a study in one location (or at one time) with the mean MWTP in another location (or time).
- These comparisons are not warranted, because one cannot assume that the underlying equilibria are the same at the two locations (or at the two times).
- The hedonic mean MWTP is a very limited concept!

Hedonic Vices: Interpretation, C

- Some studies use panel data, identify double sales, and then look at the change in house value, ΔV, as a function of the change in the amenity, ΔS.
- This strategy is equivalent to the use of a fixed effect for each house, and therefore eliminates bias in the coefficient of ΔS from all time-invariant house and neighborhood traits.

Hedonic Vices: Interpretation, C, Continued

- The problem is that the coefficient of the ΔS variable could reflect:
  - 1. The willingness to pay of households like the existing residents for the change in S.
  - 2. The willingness to pay of new, different residents (due to re-sorting) for the new S minus the willingness to pay of previous residents for the old S, which is neither group's willingness to pay.
  - 3. Shifts in the distribution of households that have nothing to do with the change in S, such as those due to immigration.
- No method now available makes it possible to separate these possibilities.

Lessons for Estimating Hedonics

- Avoid simple functional forms, which rule out sorting; avoid inconsistent forms for Rosen's 1st and 2nd stages.
- Don't include demand variables, such as household or small-area income, in a hedonic regression; do include exogenous neighborhood amenities.
- Recognize the limits of an average MWTP estimate; don't compare MWTP estimates across time or place; don't expect a hedonic in change form to estimate average MWTP.