Land Value Estimation using Teardowns

Daniel McMillen
University of Illinois at Chicago

Ruchi Singh
University of Georgia

Approaches for Estimating Land Values

- *Vacant Land Sales*

- *Hedonic Price Functions*

- *Depreciated Cost / Residual Approaches*: Estimate overall property value using a comparable sales / hedonic approach, subtract cost of building the structure as if it were new, add estimate of depreciation. Leftover is land value.

- *Hybrid Approaches*: First estimate land/price ratio then apply to hedonic price function estimates, or estimate a function for improvements and subtract from the price function.

Issues with Traditional Methods

1. Vacant Land Sales
   - Geographic coverage: built up areas tend to have few sales.
   - How representative are vacant land sales?
   - Can be very hard to classify correctly. A sale of a lot next to a home may carry one price for the combination.

But may work very well in areas with many new developments.

2. Depreciated Cost: Use RS Means data on costs to calculate value of the property as if it were new. Subtract depreciation. Result is an estimate of the value of the current structure. Subtract from sale price to get land value.
   - Works best for relatively new properties.
   - Estimates can be negative.

3. Hedonic: Standard missing variables problems. Missing variables are likely to be correlated with location.

Teardown Sales

Value of land is approximately the price of a teardown plus any demolition cost. Can help estimate land values in areas where teardowns are common, which also are areas that tend to have few vacant parcels.

Advantages:

- A direct estimate of the value of land in places where land can be hard to appraise otherwise.
- Gedal and Ellen (RSUE, 2018) directly compare land value estimates obtained using teardowns with vacant land sales and conclude that teardown sales produce more precise estimates of land value and are more representative of the full city of New York.

Disadvantages:

- Small number of sales.
- Probably does not generalize to other areas.
- Sample selection issues.
- Can be remarkably hard to identify teardown sales.
- How short does the time have to be between sale and demolition for the sale to count as a teardown?

Contributions

Two approaches for using teardowns to estimate land values,

taking advantage of the prediction that structural characteristics do not influence the sale price of teardowns.

- 1. Stein-rule Approach, based on Knight, Hill, and Sirmans (JUE, 1993).

- 2. Unconditional Expectations Approach

Data

1. Maricopa County
   - 30,740 sales of single-family homes for 2015 - 2018.
   - Only 316 identified as teardowns.
   - 4 areas with active teardown markets.

2. Chicago
   - 32,682 sales of single-family homes for 1995 - 2016.
   - 3,753 demolitions, 1,563 within 2 years of sale.
   - 6 North-side high-price community areas with active teardown markets – Lakeview, Lincoln Park, Lincoln Square, Logan Square, North Center, and West Town.
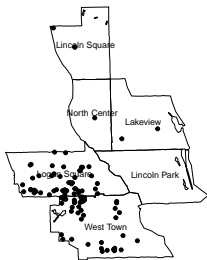
Location of Sales in Maricopa County

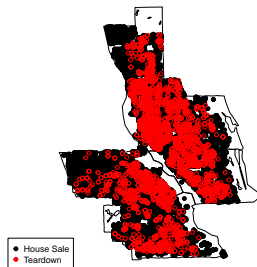Left = Vacant, Right = Homes (black) and Teardowns (red)
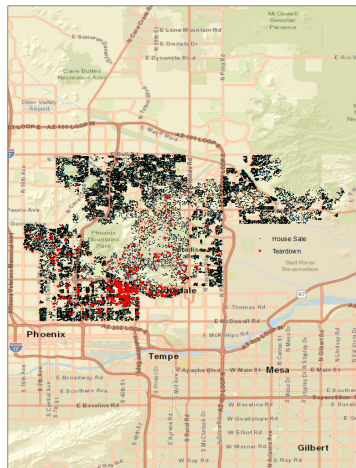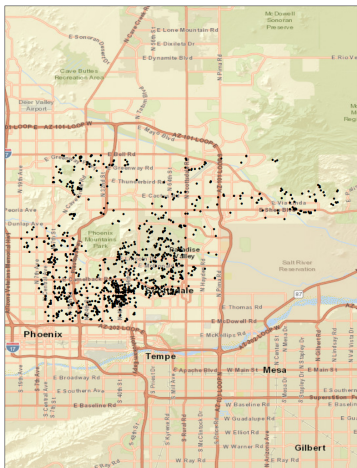
Location of Chicago Sales

Vacant Land Sales (97 Sales)

Teardowns and Single–Family Home Sales

Stein-rule Approach

- Improves efficiency by calculating weighted averages of estimates obtained from
  - an unrestricted model, and
  - a model estimated with all structural characteristics omitted

- A weighted average of estimates with and without structural characteristics more precisely estimates the coefficients on the variables representing characteristics of the lot and location
  - a tradeoff of bias for lower variance

Stein Rule

- Typical hedonic price equation expresses the natural log of the sale price of a home (P) as:

$$lnP_i = \beta_0 + S_i'\beta_S + L_i'\beta_L + D_i'\beta_D + e_i \qquad (1)$$

  S: Characteristics of the structure
  L: Location characteristics
  D: Date of sale

- If a teardown is purchased exclusively for its lot then we can expect $\beta_S = 0$
- If the restriction $\beta_S = 0$ is correct, then Equation (1)
  - Will provide unbiased estimates of β_L
  - However, the variance of the estimates may be large
      particularly, since the variables S and L are likely to be correlated

- Restricted version of the model:

$$lnP_i = \beta_0 + L_i'\beta_L + D_i'\beta_D + e_i \qquad (2)$$

Stein Rule

- $e'_u e_u$ = residual sum of squares from unrestricted model, structural characteristics included
- $e'_r e_r$ = residual sum of squares from restricted model, structural characteristics omitted
- J = number of variables omitted
- K = number of variables in unrestricted model
- n = number of observations
- $f = \frac{(e'_r e_r - e'_u e_u)/J}{e'_u e_u/(n-K)}$

Stein Rule: Place more weight on restricted estimates, β_r, when f is low:

- $\lambda = \left(\frac{J-2}{n-K+2}\right)\left(\frac{n-K}{J}\right)\left(\frac{1}{f}\right)$
- $\beta_S = \beta_u - \lambda(\beta_u - \beta_r)$

- Stein-rule estimates have lower mean squared error than unrestricted estimates.
- Increased precision is important for relatively small sample sizes for teardowns.

Teardown Sale Price Regression Results for Maricopa

	Unrestricted	Restricted	Stein-Like Rule
Log of land area	0.275**	0.441**	0.293**
Log of living area	0.497**		
Age	-0.001		
Built 1950 - 1969	0.122*		
Built Post 1969	-0.105		
Garage attached	0.068		
Garage detached	0.054		
Carport	0.143**		
No. of bath fixtures	0.001		
Storage	-0.022		
Residential quality: above average	0.106		
Distance to CBD	-0.013	-0.012	-0.013
Distance to freeway	0.182**	0.289**	0.194**
R squared	0.834	0.775	

The number of observations is 316. The base home was built before 1950. The regressions include census tract and year fixed effects. The value of the F-test for the set of structural characteristics is 10.64. The implied value of λ is 0.075, which means that the Stein-like rule places a weight of 88.8% on the unrestricted model. Standard errors are calculated using 1000 replications of a bootstrap procedure.

Teardown Sale Price Regression Results for Chicago

	Unrestricted	Restricted	Stein-Like Rule
Log of Land Area	0.836**	0.875**	0.858**
Log of Building Area	0.042**		
Age	-0.002		
Built 1900 - 1919	-0.015		
Built 1920 - 1949	-0.031		
Built post 1949	-0.167*		
Attic	-0.01		
Basement	0.022		
Brick	0.023		
Central Air	0.053		
Fireplace	-0.014		
Distance to Lake Michigan	-0.127	-0.121	-0.124**
Distance to EL stop	-0.063	-0.077	-0.071
R-squared	0.814	0.811	

Note: The number of observations is 1,563. The base home was built before 1900. The regressions include census tract and year fixed effects. The F-test value for the structural characteristics is 2.12. The implied value of λ is 0.377, which means that the Stein-like rule places a weight of 43.4% on the unrestricted model. Standard errors are calculated using 1000 replications of a bootstrap procedure.

Unconditional Expectations Approach

- Add a large number of observations by combining teardown and non-teardown sales in one model.

- Under the restriction that the coefficients on lot and location variables are the same for teardown and non-teardown sales, can potentially get much more accurate estimates of land value.

- Selection bias is a potential concern.
    - Previous research has used Heckman (1976) two-stage estimator.

Unconditional Expectations

y = sale price
P = teardown probability, S = structural characteristics
L = characteristics of the lot and location, D = controls for date of sale
Z = Explanatory variables for probit model.

1. Probit Model, y = 1 for teardown sale, 0 for non-teardown

$$Ey = \beta_0 + P(\beta_1 - \beta_0) + (1-P)S'\beta_S + L'\beta_L + D'\beta_D + \phi(Z'\theta)(\sigma_{1v} - \sigma_{0v})$$

For Maricopa County, the assessor's office classifies a sale as a probable teardown. Alternative is to classify a sale as a teardown if a demolition permit is issued within some time after a sale.

Additional information for Cook County on time when a demolition permit is issued makes it possible to estimate a duration model for the time from sale to demolition.

2. Duration Model
h(t) = hazard rate at the time of sale.

$$Ey = \beta_0 + h(\beta_1 - \beta_0) + (1-h)S'\beta_S + L'\beta_L + D'\beta_D + \phi(\Phi^{-1}(h))(\sigma_{1v} - \sigma_{0v})$$
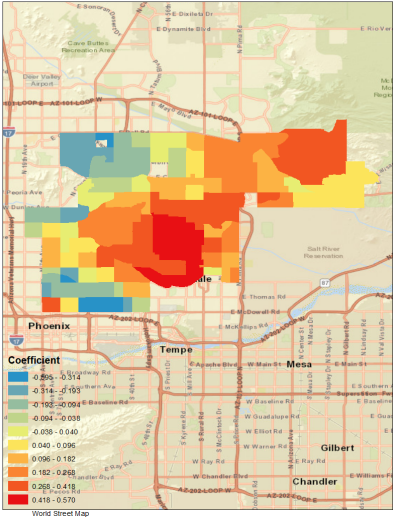
Probit Model and Unconditional Expectations: Maricopa

Variable	Probit Model	Unconditional Expectations
Log of land area	0.791**	0.168**
Larger lot size than neighbors	0.014	
Log of living area	-0.182	0.540**
Age	0.015**	-0.004**
Built 1950 - 1969	0.413**	-0.030**
Built Post 1969	0.003	-0.091**
Garage attached	-0.272**	0.096**
Garage detached	-0.265**	0.084**
Carport	-0.031	0.021**
No. of bath fixtures	-0.041**	0.022**
Storage	-0.034	0.006
Residential quality: above average	0.138	0.057**
Older than nearby buildings	0.085	
Larger building than neighbors	-0.785**	
Distance to CBD	-0.046**	-0.021**
Distance to freeway	0.434**	0.054**

Notes: The number of observations is 30,740. The base home was built before 1950. Census tract fixed effects and year of sale are included in the unconditional expectation sale price regression. The R^2 for the unconditional expectation regression is 0.88. Standard errors are calculated using 1000 replications of a bootstrap procedure.

Maricopa County Land Values

Unconditional Expectations Census Tract Fixed Effects, Teardown Probability = 1

Duration Model and Unconditional Expectations: Chicago

Variable	Duration Model	Unconditional Expectations
Log lot size	-0.465**	0.356**
Larger land area than neighbors	-0.725**	
Log of building area	0.531**	0.354**
Age	0.008**	-0.002**
Built 1900 - 1919	0.510**	0.031**
Built 1920 - 1949	1.011**	-0.004
Built post 1949	0.194	-0.033
Attic	-0.109**	-0.006
Basement	-0.023	0.089**
Brick	0.363**	0.052**
Central Air	0.319**	0.194**
Fireplace	-0.236**	0.052**
Older than nearby properties	-0.056*	
Larger building area than neighbors	-0.069	
Distance to Lake Michigan	0.276**	-0.090**
Distance to EL stop	0.086	-0.110**

Notes. The number of observations is 32,862. Control for year of sale and census tract are included in the unconditional expectation sale price regression. The R^2 for the unconditional expectation regression is 0.711. Positive coefficients in the duration model imply that increases in the variable are associated with longer times until demolition

Chicago Land Values

Unconditional Expectations Census Tract Fixed Effects, Teardown Probability = 1
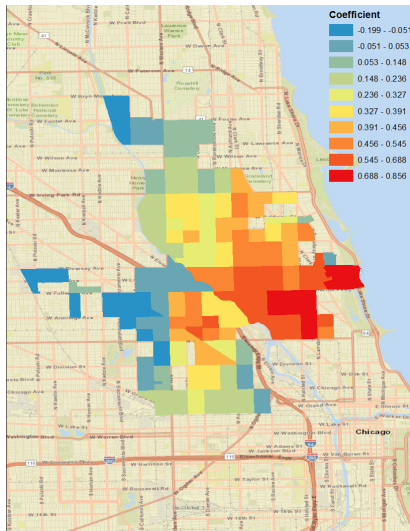
Conclusions

- Teardowns can help estimate land values in places where vacant land sales are scarce.

- A Stein-Rule approach can help increase the precision of the estimates by incorporating the reasonable restriction that structural variables do not influence teardown sales prices.

- An unconditional expectations approach can significantly increase effective sample sizes by including information on non-teardown sales.

- Teardowns are much more useful in market with many teardowns (Chicago) than in a market where they are scarce or hard to identify (Phoenix).

Thank you!