Land Valuation Using a Mix of Hedonic and Depreciated Cost Methods

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Motivation and Overview

- Our approach to this study was to follow the RFP fairly literally: “The goal of this research program is to develop practical land valuation methods that could be employed by assessors and public finance officials to measure changes in land values induced by public investment.”
- Hence, we focus on the use of information about vacant or improved residential properties that transact to infer land values. Specifically, we examine predicted or estimated land values generated using several methods:
    - Vacant land hedonic models
    - Depreciated cost analysis of improved properties (i.e., residual analysis)
    - Matching vacant and improved properties, creating a hedonic model for improvements, and using that to estimate residual land values
- We conclude that none of these methods produces sufficiently accurate land valuations
- Issues: representativeness, omitted variables, accuracy of depreciated cost analysis, data

Method 1: Vacant Land Hedonic Models

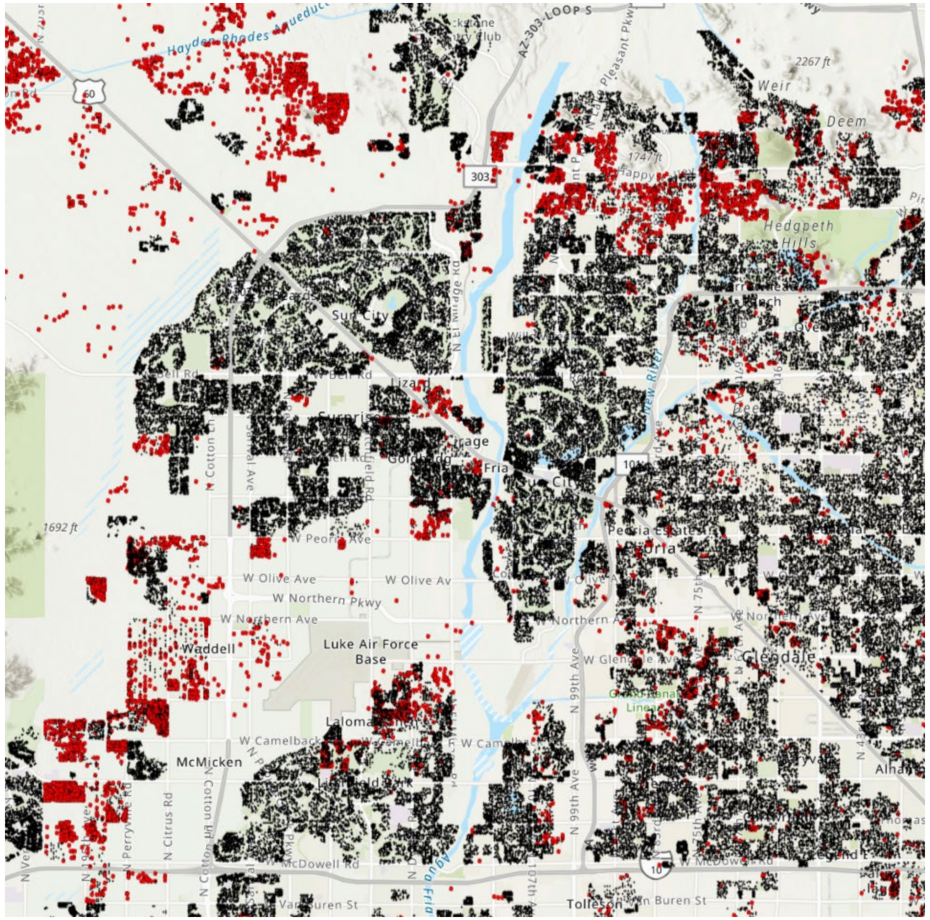
- Samples:
  - Entire county, 2015-2018 (n = 6,119)
  - Market 26 (SE of Tempe), 2015-2018 (n = 630), chosen for the relatively large number of transactions per neighborhood
- Regression model:
  - Dependent variable: ln(land price)
  - Independent variables: ln(land area), distance to CBD, floodway dummies, zoning dummies, subdivisibility dummy, market areas, quarters (note that many land-related variables were not available for improved properties and so could not be used in this model)
- Prediction accuracy measures:
  - Coefficient of Dispersion (COD): mean absolute difference between the ratios of assessed values to sales prices and the median ratio (IAAO target is between 0.05 and 0.25)
  - Price-Related Differential (PRD): mean assessment ratio divided by the value-weighted average of assessment ratios (IAAO target is between 0.98 and 1.03)
  - Mean Absolute Error (MAE) and Mean Absolute Percentage Error (MAPE, similar to COD)
  - Percentages within 10% and 20%

Method 1: Vacant Land Hedonic Models

Model	Coefficient of Dispersion (COD)	Price-Related Differential (PRD)	Mean Absolute Error (MAE)	Mean Absolute Percentage Error (MAPE)	Percentage of Predictions within 10% of Price	Percentage of Predictions within 20% of Price
Maricopa County land sales model (OLS)	47.9	1.34	67,293	57.1	16.1	31.2
Market 26 land sales model (OLS)	23.3	1.10	41,455	24.8	34.8	58.9
Market 26 land sales model (SEM)	24.2	1.11	42,501	24.8	32.2	57.8
Market 26 land sales model (robust M)	23.1	1.11	40,301	23.3	37.9	62.2

Method 1: Vacant Land Hedonic Models

- The method does not work that well within sample
- Out-of-sample results are likely to be even less satisfactory due to the locations of vacant land parcels relative to improved properties
- Although not strictly valid, we also compared coefficients for land-related variables in the land hedonic model with those for an improved property hedonic model:
  - 27 out of 39 differed at the 0.0001 level
  - 7 of the remaining estimates differed at the 0.05 level



Method 2: Depreciated Cost Analysis

- Based on RS Means cost estimates for Phoenix:
  - Valued main structure, outbuildings, swimming pools, and sports courts on a per square foot basis
  - For the main structure: four quality categories, three categories for numbers of stories, 10 size categories (120 categories in total)
  - Depreciation estimates based on RS Means and vary with quality class
  - Costs are indexed based on RS Means
- Focus on Market 26 for comparison with hedonic land valuations from Method 1:
  - First sample includes all improved properties that transacted in Market 26 during 2015-2018 (n = 31,967)
  - Second sample includes only recently improved properties (age = 0) in Market 26 that transacted during that period (n = 8,220)

Method 2: Depreciated Cost Analysis

Method (Market 26 all properties)	Mean	Median	Standard Deviation	Minimum	Maximum
Land values predicted from land hedonic model	102,049	91,035	49,379	13,351	446,584
Improvement values calculated as residual using land hedonic model	259,654	239,298	106,806	-194,132	3,125,861
Land values calculated as residual using depreciated cost method	96,756	80,471	84,127	-504,347	1,741,161
Improvement values estimated using depreciated cost method	264,947	253,508	81,017	29,055	1,758,839

Method 2: Depreciated Cost Analysis

Method (Market 26 newly improved properties)	Mean	Median	Standard Deviation	Minimum	Maximum
Land values predicted from land hedonic model	97,483	87,298	42,450	17,391	441,469
Improvement values calculated as residual using land hedonic model	294,978	272,099	96,148	-29,210	1,379,288
Land values calculated as residual using depreciated cost method	100,660	83,469	85,726	-504,347	1,051,691
Improvement values estimated using depreciated cost method	291,801	280,274	67,379	183,125	1,171,014

Method 3: Matched Transactions

- Matching:
  - Based on parcel ID numbers
  - Land transactions for the full 2000-2018 period
  - Improvement transactions for 2015-2018
  - Latest land transaction and earliest improvement transaction (*n* = 4,802)
- Valuation methods:
  - Land value indexed forward to time of improvement transaction
  - Residual improvement values used to estimate a hedonic model (*n* = 301,488)
  - Hedonic model then used to infer improvement values and residual land values
  - Note that another procedure would be needed to value vacant land
  - Compare residual land values for matched sample with inflated land values for that sample
  - For the entire sample of improved properties that transacted from 2015 to 2018, we compared results derived from the depreciated cost approach with those from the matched transaction method

Method 3: Matched Transactions

Measure (matched transaction sample only)	Mean	Median	Standard Deviation	Minimum	Maximum
Inflated land values	161,918	118,033	160,607	6,366	1,786,596
Implied improvement values	566,413	434,689	438,905	49,555	2,710,913
Improvement values predicted from improvement hedonic model	566,189	459,206	385,574	95,826	2,682,657
Land values calculated as residual using hedonic model of improvements	162,142	90,170	278,457	-898,653	2,084,000

Method 3: Matched Transactions

Measure (all improved transactions, 2015-2018)	Mean	Median	Standard Deviation	Minimum	Maximum
Land values calculated as residual using depreciated cost method	118,926	82,484	175,249	-504,347	10,476,958
Improvement values estimated using depreciated cost method	196,761	182,144	96,747	5,371	1,758,839
Land values calculated as residual using hedonic model of improvements	86,984	68,844	145,169	-1,141,033	10,147,426
Improvement values predicted from improvement hedonic model	228,703	187,372	165,516	14,754	3,579,219

Conclusions

- Based on our work to date, we are not satisfied with the results from any of the methods
- Land valuation hedonic model does not work particularly well within sample, possibly due to omitted variables, and vacant residential land sales are not representative of all residential land with respect to location; spatial and robust techniques do not help
- Depreciated cost method yields negative land values (as well as unrealistically low values for some properties and, possibly, high values for others):
  - 4% of estimates for the Market 26 full sample of improved transactions and 3.6% for Market 26 age = 0 are negative, suggesting that the depreciation estimates are not the issue
  - It is possible that there are some data issues, specifically, improved property transactions that reflect only land values
- Matched sample method also yields negative land values:
  - 19% for matched sample and 17.4% for full sample
  - Again, there may be some data issues