Matching estimation of the downstream amenity value from urban stream interventions

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Project Goal

Estimate the change in amenity value from a stream for homes *downstream* of a major intervention project through home prices using matching methods

Three econometric challenges

1. Control for observables
2. Market trends and temporal heterogeneity
3. Spatial unobservables

Step 1: Matching as data pre-processing

Two homes i (treated) and j (control) are a match if they minimize distance d_{ij}

$$d_{ij} = \sqrt{(\mathbf{x}_i - \mathbf{x}_j)' \mathbf{V}^{-1/2} \mathbf{W} \mathbf{V}^{-1/2} (\mathbf{x}_i - \mathbf{x}_j)} \qquad (1)$$

Where:

- $\mathbf{x}_i$ and $\mathbf{x}_j$ are vectors of observable variables
- $\mathbf{V}$ is the variance-covariance matrix of these observables
- $\mathbf{W}$ is a diagonal matrix of weights

We matched based on propensity score, bedrooms, bathrooms, square footage and sale year.

Step 2: Compute ATT (average treatment effect on the treated) with auxiliary bias adjustment regression

Counterfactual:

$$\hat{y_{0i}} = \frac{1}{L_{i,M}} \sum_{j \in \mathcal{J}_{i,M}} \left(y_j + \hat{\mu}_0\left(\mathbf{x}_i\right) - \hat{\mu}_0\left(\mathbf{x}_j\right)\right) \quad (2)$$

ATT:

$$\hat{\tau}_{att} = \frac{1}{n} \sum_{i=1}^{n} \left(y_{1i} - \hat{y}_{0i}\right) \quad (3)$$

Here we have **double robustness** since the ATT is unbiased if either

- The match is very good i.e. $\mathbf{x}_i \approx \mathbf{x}_j$ or,
- The bias adjustment regression gives unbiased predictions i.e. $E\left[\hat{\mu}_0\left(\mathbf{x}_k\right)\right] \approx \hat{\mu}_0\left(\mathbf{x}_k\right)$ for $k \in \{i, j\}$

Overcome 3 challenges by:

1. Step 1 of matching balances observed covariates between treatment and control sub-samples
2. Force a perfect match on home sale year
3. Include school district fixed effects in bias adjustment regression

Stream intervention projects

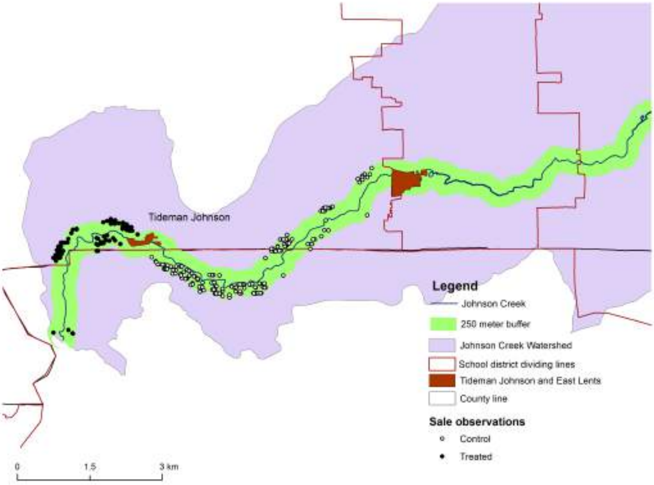
- Over a billion dollars spent annually on river and stream improvement projects in the U.S. (Bernhardt et al., 2005).
- These projects have a generally positive effect on nearby homeowners. (Streiner and Loomis, 1996, Braden and Johnston, 2004, Provencher et al., 2008, Bin et al., 2009).
- We test the effect of these projects on homes downstream from the project site.
- The effect on downstream homes has never before been investigated.

Intervention of Interest

The Tideman-Johnson project in Portland, Oregon took place in 2006 and aimed to:

1. Bury a large sewage pipe that had become exposed as it crosses the stream
2. Improve flood storage capacity
3. Create habitat for Salmon and other wildlife
4. Increase riparian plant coverage to decrease stream temperature and erosion

Study Area - Johnson Creek in Portland, Oregon



Results

Table: Summary of estimation - ATT of Tideman-Johnson project

Parameter	Full sample	homes w/in 1 km of Tideman-Johnson	homes over 1 km from Tideman-Johnson
Post-intervention	160.208	185.984	88.060
Pre-intervention	88.770	116.575	44.941
Difference - ATT	**71.846**	**69.279**	**43.509**

Conclusions

- Preliminary results estimate the amenity value of the intervention for downstream homes as \$71,000 with a 95% credible interval from \$41,000 to \$101,000
- Mean home value for the post-intervention downstream sample is \$377,800, so ATT is about 20% of value.
- Such a large amenity effect may be driven by the decrease in flood risk for downstream homes as a result of the Tideman-Johnson project.
- The amenity value from the project is shown to decrease with distance downstream from the project

References

E. S. Bernhardt, et al.
Synthesizing U.S. river restoration efforts.
Science, 308(5722):636–637, 2005.

Okmyung Bin, Craig Landry, and Gregory Meyer.
Riparian buffers and hedonic prices: A quasi-experimental analysis of residential property values in the Neuse River Basin.
American Journal of Agricultural Economics, 91(4):1067–1079, 2009.

John Braden and Douglas Johnston.
Downstream economic benefits from storm-water management.
Journal of Water Resources Planning and Management, 130(6):498–505, 2004.

Bill Provencher, Helen Sarakinos, and Tanya Meyer.
Does small dam removal affect local property values? An empirical analysis.
Contemporary Economic Policy, 26:187–197, 2008.

Carol Streiner and John Loomis.
Estimating the benefits of urban stream restoration using the hedonic price method.
Rivers, 5(4):267–278, 1996.

Data

	Pre-intervention (1990-2005)	Post-intervention (2007-2014)
Upstream (control) sales	682	210
Downstream (treated) sales	271	107

Table: Tideman-Johnson home sales observations

- All homes are within 250 meters of Johnson Creek.

Additional Challenges

- For a different intervention site we must develop a triple difference method to account for spatial fixed effects which are not identified in the bias adjustment regression.