Online Appendix

Peer Effects in Residential Water Conservation: Evidence from Migration

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A Further Data Details

A.1 Details on Data Cleaning

The raw water consumption data set contains 2,599,862 observations and 308,529 households. Often the utility will make billing adjustments by manually changing a household's water consumption in a particular month to either credit or charge an account. Hence, negative and extremely large consumption values are either errors or billing adjustments and do not reflect actual consumption. Accordingly, we drop annual consumption below the 1st percentile of consumption and above the 99th percentile of consumption, as these are very likely to be outliers that do not reflect actual consumption. For our main specification, we also drop houses that were sold anytime during the current summer months, the current non-summer months, or the lagged summer months (196,925 observations). We also do not have sales price information for all peer groups. For example, if no houses were sold within the peer group for a particular time period. This drop an additional (589,383 observations). Finally, including household-level fixed effects leads to 27,997 singleton observations. The remaining data set, after dropping parcels that had a transaction in the last year, has 1,535,545 observations and 260,307 households.

The raw fitted landscaping data set contains 544,882 observations and 74,112 households. Again, we drop observations below the 1st percentile of consumption and above the 99th percentile of consumption for similar reasons as above. The remaining data set contains 540,451 observations and 72,007 households. Finally, including household-level fixed effects leads to 7,313 singleton observations, resulting in a final data set of 531,650 observations and 71,477 households.

A.2 Further Summary Statistics

This appendix section contains summary statistics for some of the physical household characteristics.

Table A.1: Summary Statistics for Household Characteristics

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**
# bathroom fixtures	6.92	2.32	2	31
house size (ft^2)	1,716	607	288	11,564
pool dummy	0.344	0.475	0	1
lot size (ft^2)	8,148	3,612	531	131,979

Notes: Means are taken over the 130,382 households in the water data.

Table A.2: Means of Movers and Non-moving Peers

	(1) sold house	(2) peer mean	(3) t-statistic
household income (10 brackets)	6.09	6.07	0.38
education level (6 brackets)	1.69	1.68	0.23
1(Democrat)	0.29	0.31	1.17
house price (15 brackets)	10.63	10.58	0.77

Notes: These data on demographics were acquired from Acxiom at the address level. The t-statistic is the statistic for a two-sided test of difference in means.

A.3 Further Details on the Remote Sensing Data Processing

The remote sensing data is three-inch resolution resulting in up to seven terabytes of remote sensing data for all eight years of the sample. To reduce computational burden, we chose image samples from the city, resulting in approximately one terabyte of remote sensing data for the sample period.

To process the images, we used Erdas Imagine software's Supervised Classification routine. This is a common routine used by many in the remote sensing community, including many graduate students in geography. The routine proceeds as follows: the user selects pixels that represent patterns in the images, which are then placed into classes or categories by the user. In our case, we selected pixels that represented green landscaping including grass, trees, or shrubbery as our primary class of interest. The second class, by default, is all other types of land cover. The program uses the mean and covariance matrix of the values of the image bands (e.g., red, blue, green) of the selected pixels to produce a "parametric signature" for the specified classes of pixels. This process produces a training sample that the program then uses to classify pixels in a selected out-of-sample subsample of data. The program uses maximum likelihood to determine the probability that a particular pixel in the out-of-sample data belongs in either class. The user then evaluates the out of sample classification to determine if the training sample effectively classifies green landscaping out-of-sample. If not, then the initial classes are updated and the process is repeated. In this way, the process is iterative. Once, the training sample is deemed appropriate, then the program uses the training sample to classify the remaining pixels in the data. For further details on the approach and for the exact equations used, see `http://geography.middlebury.edu/data/gg1002/Readings/Extras/ERDAS_FieldGuideClassification.pdf`.

B Event Study of the Effect of Housing Transactions on Water Use and Landscaping

This Appendix presents further evidence on how home sales are correlated with changes in summer water consumption and landscape choices, which motivates the first stage of our regression.

B.1 Water Consumption and Movers

We begin by performing an event study-stye analysis on summer water consumption, following equation (1). The key point of this estimation is to see how water consumption changes for households before and after a move. The results from estimating the event study are presented in Table A.3. Column 1 includes data from the year of the move and the year prior to the move. Column 2 includes data from the year of the move, 1 year after the move, and 2 years prior to the move. The omitted category is 2 years prior to the move in column 2. Column 3 includes data from the year of the move, 2 years after the move, and 3 years prior to the move. The omitted category is 3 years prior to the move in column 3.

The results in Table A.3 show that summer water consumption after a home sale decreases relative to a baseline prior to the sale. This decrease continues in the years after the sale. We also see a small increases in summer water consumption the year prior to sale, which is consistent with home owners watering lawns and greenery to increase the visual aesthetic of a home on the market. The results in column 3 of Table A.3 are used to create Figure 4.

B.2 Landscaping and Movers

For landscaping, we first regress the square footage of green landscaping on a year fixed effect to at least partly remove intertemporal measurement error in the landscape data. We use the residuals from this regression as our measure of green landscaping for our

Table A.3: Change in Water Consumption Before and After a Move

	(1)	(2)	(3)
2 years prior to sale			-0.00
			(0.06)
1 year prior to sale		0.46***	0.50***
		(0.09)	(0.09)
year of sale	-2.93***	-1.28***	-0.95***
	(0.12)	(0.15)	(0.14)
1 year after sale		-1.06***	-0.87***
		(0.30)	(0.24)
2 years after sale			-0.47**
			(0.22)
R-squared	0.69	0.64	0.48
N	43,715	66,282	148,630

Notes: This table presents the coefficients showing the change in summer water consumption from estimating the model in (1). The omitted year is always one year less than the earliest year presented. For example, the omitted year in column 2 is 2 years prior to the home sale and the omitted year in column 3 is 3 years prior to the home sale. Standard errors are clustered at the Census block level. *** denotes significance at 1% level, ** at 5% level, * at 10% level.

event study, which we call $\Delta landscape_{it}$. We then estimate Equation (1) using $\Delta landscape_{it}$ as the dependent variable. The results of the landscaping event study are presented in Table A.4. The coefficients indicate statistically significant declines in green landscaping the year of the home sale and for up to 2 years after the home sale. However, unlike Table A.3, we do not find statistically significant increases in green landscaping the year prior to the move. While only suggestive, this may indicate that some of the increase in water consumption prior to the move may be caused by non-landscaping uses of water consumption, such as increasing the number of watered indoor plants.

Table A.4: Change in Green Landscaping Before and After a Move

	(1)	(2)	(3)
2 years prior to sale			-15.05
			(18.83)
1 year prior to sale		7.66	-12.49
		(18.69)	(19.81)
year of sale	-49.21**	-50.90**	-47.57**
	(21.96)	(19.58)	(19.29)
1 year after sale		-37.37**	-55.92***
		(17.27)	(19.33)
2 years after sale			-48.40***
			(13.70)
R-squared	0.11	0.11	0.11
N	14,508	29,699	37,300

Notes: This table presents the coefficients showing the change in summer water consumption from estimating the model in (1), only with water consumption replaced by green landscaping. The omitted year is always one year less than the earliest year presented. For example, the omitted year in column 2 is 2 years prior to the home sale and the omitted year in column 3 is 3 years prior to the home sale. Standard errors are clustered at the Census block level. *** denotes significance at 1% level, ** at 5% level, * at 10% level.

We can quickly visualize the results in column 3 of Table A.4 in Figure A.1.

Finally, we show the water event study figures for SPR houses and non-SRP houses in Figures A.2 and A.3 respectively. These two figures provide evidence that the first stage is strong for both SRP and non-SRP houses.

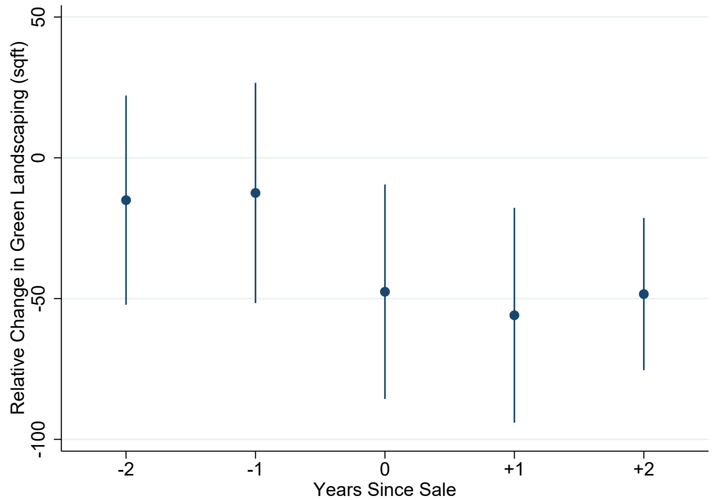

Figure A.1: Change in landscaping by year since a housing transaction occurs (Year 0 = year of transaction). Only homes that have a transaction are included. All changes are relative to year -3. See Table A.4 for the full regression results.

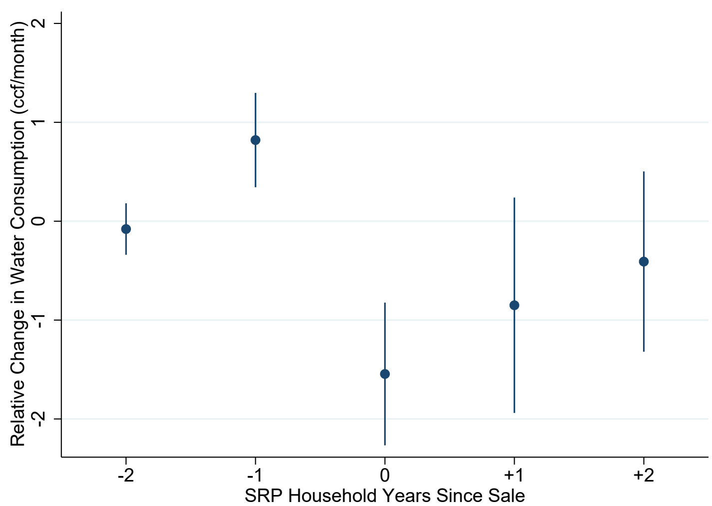

Figure A.2: Change in water consumption for SRP houses only, by year since a housing transaction occurs (Year 0 = year of transaction). Only homes that have a transaction are included. All changes are relative to year -3.

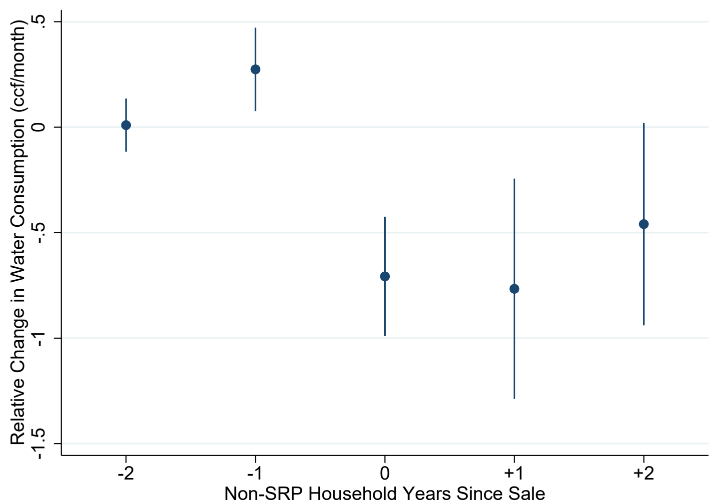

Figure A.3: Change in water consumption for non-SRP houses only, by year since a housing transaction occurs (Year 0 = year of transaction). Only homes that have a transaction are included. All changes are relative to year -3.

C First Stage Results

This appendix provides the results from the first stage of the IV specifications in our results.

Table A.5: First Stage for Preferred IV Specification

	(1)	(2)
mean peer sales in $t-1$	-1.72***	-1.75***
	(0.06)	(0.08)
peer sales prices (1000's \$ /1000ft^2)	39.10***	29.30***
	(5.60)	(5.63)
Δ peer sales prices (1000's \$ /1000ft^2)	-41.71***	-34.88***
	(6.05)	(5.91)
fraction peer new construction	-2.85***	-3.54**
	(1.06)	(1.38)
Household Fixed Effects	Y	Y
Year by Subdivision Dummies	Y	N
Year by Census Block Dummies	N	Y
R-squared	0.54	0.63
N	1,537,435	1,535,545

Notes: This table presents the first stage results from our preferred IV specifications in Table 2. The dependent variable is the mean peer consumption in $t-1$. The independent variable of interest is the fraction of houses sold in the peer group (mean peer sales in $t-1$). Standard errors are clustered at the Census block level. All models estimated in first differences. *** denotes significance at the 1 percent level, ** at the 5 percent level, * at the 10 percent level.

Table A.6: First Stage for Placebo Checks

	(1)	(2)
mean peer sales in t	-2.62***	-2.44***
	(0.09)	(0.12)
peer sales prices (1000's \$ /1000ft^2)	-2.32	8.37
	(5.90)	(6.94)
Δ peer sales prices (1000's \$ /1000ft^2)	14.57***	3.12
	(5.55)	(6.22)
fraction peer new construction	-4.88***	-7.71***
	(1.12)	(1.54)
Household Fixed Effects	Y	Y
Year by Subdivision Dummies	Y	N
Year by Census Block Dummies	N	Y
R-squared	0.53	0.62
N	1,500,611	1,498,693

Notes: This table presents the first stage results from our preferred IV specifications in Table 3. The dependent variable is the mean peer consumption in t. The independent variable of interest is the fraction of houses sold in the peer group (mean peer sales in t). Standard errors are clustered at the Census block level. *** denotes significance at the 1 percent level, ** at the 5 percent level, * at the 10 percent level.

Table A.7: First Stage for Role of Economic Incentives

	(1) SRP-eligible	(2) Matched non-SRP
mean peer sales in $t-1$	-2.19***	-1.51***
	(0.11)	(0.10)
peer sales prices (1000's \$ /1000ft^2)	19.03**	39.90***
	(7.80)	(12.48)
Δ peer sales prices (1000's \$ /1000ft^2)	-21.53***	-48.15***
	(7.61)	(13.76)
fraction peer new construction	-4.87**	1.98
	(2.34)	(2.18)
Household Fixed Effects	Y	Y
Year by Census Block Dummies	Y	Y
R-squared	0.70	0.62
N	604,244	689,195

Notes: This table presents the first stage results from our preferred IV specifications in Table 7. The dependent variable is the mean peer consumption in $t-1$. The independent variable of interest is the fraction of houses sold in the peer group (mean peer sales in $t-1$). Standard errors are clustered at the Census block level. All models estimated in first differences. *** denotes significance at the 1 percent level, ** at the 5 percent level, * at the 10 percent level.

D Informal Survey of Landscapers

This appendix provides additional details on our informal survey of landscapers in Phoenix. This survey was performed on June 11-13, 2019.

The goal of the phone survey is to determine whether landscapers do actually perform highly localized marketing. Note that conversations with family and friends who live in Phoenix suggested to us that they do not, but the survey is intended to provide clearer evidence of this.

We performed a Google search for "Phoenix landscaper." We called the first 20 of the landscapers that received star ratings above 3 stars. We were able to get 7 out of the 20 landscaping companies on the phone and willing to answer our questions (a response rate of 35%). The landscapers who we were able to speak to were the following: Crystal Green Landscaping, Outside Living Concepts, HMI, Landscaping Services Phoenix, Hawkeye Landscaping Inc, Master Azscapes, and Landscaping Contractors.

We asked the following three questions:

1. When your company performs a landscape conversion on residential properties, not simply maintenance, do you actively market to the nearest neighbors by knocking on doors?

2. When your company performs a major landscape conversion on residential properties, not simply maintenance, do you put up marketing signs in the yard that you are converting?

   - If so, how long do you leave the signs up?

3. Does your company market to people who recently moved into a neighborhood by sending promotional material in the mail?

Our results are the following. None of the firms actively marketed by sending information in the mail or knocking on doors. 4 out of the 7 companies put signs in the yards of the homes they are working on, and the signs remain in place for the duration of the job, and then they are taken down. Note, that if these signs influence neighbors to change their landscaping too, then this would be considered a demand-side factor, as it is a peer making a decision to landscape (and thus have the sign put up) that influences the individual to make the decision. The companies stated they spend most of their marketing funds on websites and online advertising.

Taken together, we see these findings as strongly suggesting that our results are unlikely to be driven by supply-side effects.

E Robustness Checks

This section presents a set of additional robustness checks. The first, in Table A.8, examines whether there is clustering in peer housing transactions, which could suggest sorting affecting our instrument. We regress a dummy for whether a house is sold on the fraction of housing transactions. The coefficient on the fraction of housing transactions is not statistically significant and is close to zero, suggesting that this type of clustering is not a concern.

Table A.8: Clustering in Peer Housing Transactions?

	1(sold)
fraction of housing transactions $t-1$	0.01
	(0.01)
Household Fixed Effects	Y
Census Block x Year Dummies	Y
R-squared	0.06
N	1,535,871

Notes: This table reports the results of regressing a dummy variable for whether house i was sold in period t on the fraction of parcels with housing transactions within 500′ in the previous year, which is our instrumental variable in the primary regressions. The model is estimated in first differences to difference out the household effects. The number of observations is not the same as our primary specification because in our primary specification, we drop houses sold in year t. Standard errors are clustered at the Census block level. *** denotes significance at 1% level, ** at 5% level, * at 10% level.

The next robustness check, in Table A.9, examines our primary IV specification as in column 4 of Table 2, only using different definitions of the peer group. Specifically, we use 400′, 600′, and 700′ radii. The results show similar peer effects out to 700′, but the effects slightly weaken as the radii become larger, as one would expect. The peer effect coefficient does not become statistically insignificant until we go our to 1000′.

In Table A.10, we redefined the peer group to drop peers in other Census blocks. After this redefinition, the average peer group has 13 households, rather than 25.3 households. We find a similar peer effect coefficient, although the coefficient is even larger. This might be expected because this peer group definition is capturing closer peers who are more likely to interact with the household.

Table A.9: Robustness: Different Radii

	(1) 400′	(2) 600′	(3) 700′
mean peer consumption in $t-1$	0.26**	0.22***	0.21***
	(0.06)	(0.06)	(0.06)
Housing price controls	Y	Y	Y
New construction controls	Y	Y	Y
Household Fixed Effects	Y	Y	Y
Census Block x Year Dummies	Y	Y	Y
First Stage F-stat	4792	5602	5734
R-squared	0.07	0.07	0.07
N	1,571,039	1,672,005	1,686,514

Notes: All columns run our preferred IV specification using the fraction of movers in the peer group as the instrument for the peer group variable. Each column uses a different radius for the peer group definition. On average, there are respectively 22.9, 26.25, and 26.7 houses within a 400, 600, and 700 foot radius of any household in our study. The models are estimated in first differences to difference out the household effects. Standard errors are clustered at the Census block level. *** denotes significance at 1% level, ** at 5% level, * at 10% level.

Table A.10: Redefined Peer Group to Drop Peers in Other Blocks

	(1) OLS	(2) IV
mean peer consumption in $t-1$	0.35***	0.33***
	(0.01)	(0.05)
Household Fixed Effects	Y	Y
Year by Census Block Dummies	Y	Y
First Stage F-statistic	N/A	4762
R-squared	0.08	0.08
N	1534843	1534843

Notes: This table replicates columns 2 and 4 of Table 2, only we redefined the peer group to drop peers in other Census blocks. Standard errors are clustered at the Census block level. The models are estimated in first differences to difference out the household effects. *** denotes significance at the 1 percent level, ** at the 5 percent level, * at the 10 percent level.

Table A.11: Lagged Peer Effects

	OLS	IV	OLS	IV
mean peer Δ consumption in $t-1$	0.38***	0.35***		
	(0.01)	(0.06)		
mean peer Δ consumption in $t-2$	0.17***	0.17***	0.06***	0.11*
	(0.01)	(0.06)	(0.01)	(0.07)
Household Fixed Effects	Y	Y	Y	Y
Census Block x Year Dummies	Y	Y	Y	Y
Housing price controls	Y	Y	Y	Y
New construction controls	Y	Y	Y	Y
First Stage F	N/A	2133.258	N/A	3902.078
R-squared	0.077	0.077	0.074	0.074
N	1514990	1514990	1514990	1514990

Notes: This table reports the results of estimating our primary peer effects specification using OLS and IV, but including mean peer Δ consumption in $t-1$ and mean peer Δ consumption in $t-2$. The models are estimated in first differences to difference out the household effects. Standard errors are clustered at the Census block level. *** denotes significance at 1% level, ** at 5% level, * at 10% level.

E.1 Robustness: Discrete Switches Specification

We next we examine a robustness check that uses discrete downward switches in water consumption, rather than the level of water consumption. The idea behind the approach is that the peer effects in water consumption are most likely driven by conversions of green landscaping to dry landscaping, so a specification that looks at the relationship between large persistent reductions in summer water consumption by peers and large persistent reductions by an individual household can provide further useful evidence.

An approach based on persistent decreases in summer water consumption raises the question of what threshold to use for the change in water consumption that would be consistent with a change in landscaping. If we use a very high threshold–such as the difference between the average summer and non-summer water consumption–we will miss more modest landscape changes and may also miss changes that occur in parcels with small lot sizes. If we use too low of a threshold, we risk simply picking up noise, rather than real changes in water consumption. Further, if we use a threshold based on a percentage of water consumption or greenness, translating our results to gallons saved would be much more difficult.

These considerations suggest a threshold that is roughly one half the average difference between the summer and non-summer season water consumption, which comes out to be about 2.8 ccf. For reference, a widely used irrigation calculator for Mesa, AZ indicates that 36 gallons per square foot is required in a summer month,[37] so if all of the decrease in water usage is from dry landscaping, 2.8 ccf would imply a switch of just over 50 square feet of irrigated landscaping to dry landscaping. This threshold captures a noticeable change, but still leaves open the possibility for an average household to have multiple switches in the time frame of our data if the household phases in dry landscaping over time. For some large parcels it is even possible to have more than two switches over different seasons.

We should emphasize that it is important that the decrease in water consumption is

[37] http://apps.mesaaz.gov/watercalculator/

persistent. We would not want to classify households as making a switch if they decrease their water consumption in one season and then increase it the next season, as might be expected when there is mean reversion. Thus, we define a switch in water consumption as a decrease of at least 2.83 ccf in monthly water consumption during the summer months that is persistent through at least the following year. For example, the dummy variable for a switch is equal to one for a household if the household exhibited a decrease in consumption between summers $t-1$ and t that was greater than 2.8 ccf and persisted for at least one more season. An alternative definition we considered requires persistence for multiple seasons, or even until the end of our time frame. This alternative approach is problematic because it treats households making a switch early in our sample differently than households making a switch later in our sample. Thus, our preferred definition considers persistence for one additional season ($t+1$), but we also explore results using the alternative definition to show that mean reversion does not appear to be an issue.

In our sample, 37,098 parcels make more than one switch, 51,581 make a single switch, and the remaining 41,703 make no switches. The largest number of switches in our sample is four, which happens to be for a very small number of parcels with large lot sizes. For households that make one switch, the average difference between the summer and non-summer water consumption per month is 6.6 ccf before the switch and 3.9 ccf after the switch (for the full remainder of the time period in our sample). Similarly, for households that make more than one switch, the average difference between the summer and non-summer water consumption per month is 9.3 ccf before the switch and 5.4 ccf after the switch (for the full remainder of the time period). These statistics indicate that the switches we are modeling are indeed persistent switches and are not simply capturing random variation.

We similarly define our peer decision variable as the average fraction of houses in $i's$ peer group that made a switch between the $t-2$ and $t-1$ summers that persists for at least one more season. Finally, we create a variable for the fraction of houses in $i's$ peer group that were sold between the growing and non-summer months of $t-2$ and $t-1$

(including the non-summer months of $t-1$).

In this 'switches' specification, we model a persistent switch in water consumption during the summer months by household i in year t as a function of the peer group's aggregate choices in $t-1$, peer group housing attributes, time-invariant household characteristics, and time-varying characteristics of the local neighborhood or Census block b:

$$1(\Delta w_{i,t}) = \theta \overline{\Delta w}_{i,t-1} + \delta H_{i,t} + \eta_i + \phi_{t,b} + \epsilon_{i,t}. \tag{3}$$

The term $1(\Delta w_{i,t})$ is a dummy for a persistent switch in summer water consumption.

If we denote household i's peer group as the set P_i, then $\overline{\Delta w}_{i,t-1} = \frac{1}{|P_i|}\sum_{i' \in P_i} 1(\Delta w_{i',t-1})$ is the fraction of household i's peers that complete a major transition in the previous summer, not including household i. $H_{i,t}$ is a vector that includes the average house price in the peer group in t, the change in the average house price in the peer group between t and $t-1$, and the fraction of homes in the peer group that are new construction. η_i contains time-invariant household characteristics, which we model as a household fixed effect (i.e., a fixed effect for each parcel x owner combination, so that there is a different fixed effect after a sale). $\phi_{t,b}$ captures time-varying factors such as localized economic shocks, gentrification, vegetation shocks such as ash borer infestations, or major new development in a neighborhood, and we model this with Census block x year fixed effects.

The results are in Table A.12 and they show clear evidence of a peer effect in terms of downward switches. If there is a larger fraction of peers that make a downward switch, there is also a higher probability of a household making a downward switch. The instruments are strong in this specification, with F-statistics above 700. The placebo tests also hold with this specification, and we find that the specification is robust to the exact choice of the threshold (shown in Table A.13).

One might be concerned that the IV estimates are larger than the OLS estimates in the downward "switches" specification. There are several possible reasons for why this might happen in this particular specification. For instance, consider the possibility of attenuation bias from classical measurement error. Recall that we have very rich fixed effects in our specification, and one often worries more about measurement error with highly disaggregated fixed effects. We expect measurement error to be more problematic when using the downward "switches" specification because this specification converts a continuous variable to a dummy variable. On the other hand, a continuous specification estimated in first differences allows us to use more of the variation in the data, so measurement error would be expected to be less of an issue.

Table A.12: Robustness Check Using Downward Switches in Water Consumption

	(1) OLS	(2) OLS	(3) IV	(4) IV
fraction of peer switches in $t-1$	0.03***	0.06***	0.36**	0.35**
	(0.005)	(0.007)	(0.14)	(0.15)
Housing Market Controls	Y	Y	Y	Y
Household Fixed Effects	Y	Y	Y	Y
Subdivision x Year Dummies	Y	N	Y	N
Census Block x Year Dummies	N	Y	N	Y
First Stage F-statistic	N/A	N/A	796	880
R-squared	0.19	0.22	0.19	0.22
N	1,546,584	1,545,060	1,546,584	1,545,060

Notes: The dependent variable is 1(household persistent switch in water consumption in t), where a switch is defined as an average reduction during summer months of at least half the difference between the summer and non-summer consumption that is persistent in the next season. An observation is a household parcel-year. The peer group is defined as all houses within a 500′ radius of the household and on average, there are 25.3 houses within a 500′ radius of any household in our study. The 'fraction of peer switches' refers to the fraction of households in the peer group that make a switch in water consumption in the previous summer. Column 1 and 2 present OLS peer effect results. Columns 3 and 4 instrument for the fraction of peer switches using the fraction of parcels with housing transactions within 500′ in the previous year. Standard errors are clustered at the Census block level. *** denotes significance at 1% level, ** at 5% level, * at 10% level.

In this 'switches' specification, we can also examine specifications to help better understand the nature of the peer effects. For example, we can perform the same 'switches' regressions only using non-summer water consumption. Similarly, we can look at upward switches instead of downward switches to see if the peer effects are asymmetric. Finally, we can use the landscaping subsample and add the landscape greenness, as we do in Table 5 to see whether any peer effects remain after landscape greenness is controlled for.

Table A.14 provides this further evidence using the switches specification. In column 1, we see that there is no evidence of a peer effect in non-summer water consumption (indicative of landscaping being a primary driver). In column 2, we see that the peer effect seems to be asymmetric and only applies for decreases in water consumption. This finding is consistent with conversion to dry landscaping being a primary force. In column 3, we see that when landscape greenness is added, the peer effect coefficient becomes statistically insignificant, providing further evidence in support of the findings in Table 5.

Table A.13: Robustness: Alternative Thresholds for Defining a Switch

	(1) 35th	(2) 25th	(3) 10th
fraction of peer switches in $t-1$	0.64***	0.35**	0.26**
	(0.24)	(0.15)	(0.13)
Housing Market Controls	Y	Y	Y
Household Fixed Effects	Y	Y	Y
Census Block x Year Dummies	Y	Y	Y
First Stage F-statistic	430.723	879.3	1514.49
R-squared	0.22	0.21	0.22
N	1,545,060	1,545,060	1,532,692

Notes: The dependent variable is 1(household switch in water consumption in t). Each column presents the results from a specification that is the same as in Table A.12, only with a different threshold for defining a "switch." All specifications instrument for the fraction of peer switches using the fraction of parcels with housing transactions within 500′ in the previous year. An observation is a household parcel-year. All variable definitions are the same as in Table 2. Standard errors are clustered at the Census block level. *** denotes significance at 1% level, ** at 5% level, * at 10% level.

Table A.14: Further Evidence on Peer Effects in Switches

	(1) Non-summer usage	(2) Increase in use	(3) Landscape added
fraction of peer switches in $t-1$	0.02	0.08	-0.35
	(0.18)	(0.42)	(0.47)
household landscape greenness			-0.01***
			(0.003)
Housing Marking Controls	Y	Y	Y
Household Fixed Effects	Y	Y	Y
Census Block x Year Dummies	Y	Y	Y
First Stage F-statistic	1177.3	143.6	31.4
R-squared	0.23	0.25	0.14
N	1,545,060	1,545,060	306,480

Notes: Column 1 uses downward persistent switches in water consumption in the non-summer for both the dependent variable and the peer group variable. Column 2 uses increases in water consumption (upward switches) for both the dependent variable and the peer group variable. Column 3 is identical to Column 4 in Table 2, only with the new covariate, which is household i's landscape greenness. All specifications instrument for the fraction of peer switches using the fraction of parcels with housing transactions within 500′ in the previous year. An observation is a household parcel-year. Standard errors are clustered at the Census block level. *** denotes significance at 1% level, ** at 5% level, * at 10% level.

E.2 Robustness: Dropping All Sold Homes

In the next robustness check, we address the concern that the changes in summer water consumption prior to the year of sale might suggest that some of the peer effect is due to increases in water consumption prior to the year of sale. To address this concern, we re-estimate our primary model with Census block x year fixed effects using OLS and IV but dropping all houses that were sold during the entire sample period. For reference, in our primary specification, we drop homes that were sold in year t. The results are presented in Table A.15. We find the results do not qualitatively change, although the coefficient is a bit smaller. This might not be surprising because we are looking at an unusually selected sample in this robustness check.

Table A.15: Robustness check dropping all sold homes

	(1)	(2)
	OLS	IV
mean peer Δ consumption in $t-1$	0.31***	0.14**
	(0.01)	(0.07)
Housing Marking Controls	Y	Y
Household Fixed Effects	Y	Y
Census Block x Year Dummies	Y	Y
First Stage F-stat	NA	3659
R-squared	0.09	0.09
N	1,158,216	1,158,216

Notes: This table replicates columns 2 and 4 of Table 2 but dropping homes that were sold at any time during our sample period. The models are estimated in first differences to difference out the household effects. Standard errors are clustered at the Census block level. *** denotes significance at 1% level, ** at 5% level, * at 10% level.

E.3 Robustness: Peer Effects in Landscaping

In this short appendix, we present the results directly estimating peer effects in landscaping using our remote sensing data. As mentioned in the main text, we are concerned about the intertemporal measurement error in the remote sensing data, which is a non-classical measurement error because the magnitude of the error is likely correlated with the size of the dependent variable. For instance, larger lots are likely to have more green landscaping simply because they have more space to do so due to the fact that homes only cover so much space. However, larger lots are also likely to contain more measurement error in the remote sensing data because they also have more shadows or tree coverage, which the remote sensing algorithm cannot control for. For this reason, a simple IV approach would not address the non-classical measurement error present in the remote sensing images.

To address the intertemporal measurement error, we use a data correction procedure outlined in section 3.2 of the working paper Burkhardt et al. (2019).[38] Note this working paper is on an entirely different topic (the value of conformity in home prices) and does not include these peer effects results.

In Table A.16 below, we present our preferred peer effects specifications (columns 2 and 4 of Table 2) using the corrected landscaping data. We have far fewer observations than in our main sample because we do not have remote sensing images of all houses in the sample. However, the results provide evidence that there are peer effects in landscaping itself, which further supports our contention that the water consumption peer effects we find (which are the policy-relevant peer effects) can be at least primarily attributed to changes in landscapes.

If we use the uncorrected landscape data, we see positive coefficients similar to the ones in A.16, but our instrument is weak and we do not find statistically significant coefficients in our IV specification.

[38] This paper can be accessed at: https://drive.google.com/file/d/1c6sBbsD5Z3Sb1ZU0TlAVuuD9OXwOk44j/view.

Table A.16: Peer Effects in Landscaping

	(1) OLS	(2) IV
mean peer landscaping in $t-1$	0.32***	0.28**
	(0.01)	(0.12)
Housing market controls	Y	Y
Household Fixed Effects	Y	Y
Census Block x Year Dummies	Y	Y
First Stage F-statistic	N/A	202
R-squared	0.08	0.06
N	1,109,674	1,109,674

Notes: The dependent variable in each specification is corrected landscaping greenness in t. An observation is a household parcel-year. The peer group is defined as all houses within a 500′ radius of the household and on average, there are 25.3 houses with a 500′ radius of any household in our study. The ′mean peer landscaping in $t-1$′ refers to the average peer corrected landscaping. Column 1 presents OLS peer effect results of our preferred specification. Column 2 instruments for peer landscaping using the fraction of parcels with housing transactions within 500′ in the previous year. All models are estimated in first differences. Standard errors are clustered at the Census block level. *** denotes significance at 1% level, ** at 5% level, * at 10% level.

F Additional Tables of Balance

The following table displays comparisons of summary statistics of important observable household and demographic characteristics for key subsets of our data. Table A.17 compares the means of key variables between the water consumption data and the landscaping data. We performed two-sided t-tests of differences in means for each variable and report the standard errors of the differences in means in parentheses below the differences in means in column 3 of the table. Table A.18 presents further summary statistics of key variables for the matched and unmatched samples used in Table 7 in the primary text.

Table A.17: Summary Statistics by Water and Landscape Data Sets

	Water Data	Landscape Data	Difference
median household income (1000s $)	60.0	62.9	-2.9
	(24.1)	(24.0)	(37.2)
lot size (1000s ft^2)	8.1	8.7	-0.6
	(3.6)	(4.1)	(6.0)
house sqft (1000s ft^2)	1.7	1.8	-0.06
	(0.61)	(0.60)	(0.94)
# bath fixtures	6.9	7.1	-0.14
	(2.3)	(2.3)	(0.004)
% white	72.1	75.5	-3.4
	(16.8)	(14.3)	(0.03)
% black	4.8	4.4	0.36
	(4.5)	(3.5)	(0.007)
% latino	33.1	26.3	6.7
	(26.8)	(22.2)	(0.04)
N	260,307	71,477	N/A

Notes: Column 1 reports means for households in the water consumption data with standard deviations in parentheses. Column 2 reports means for households in the landscape data with standard deviations in parentheses. Column 3 reports the difference in means with standard errors of differences in means in parentheses.

Table A.18: Summary Statistics by SRP Status

	(1)	(2)	(3)
		Matched	
	SRP	non-SRP	non-SRP
median household income (1000s $)	45.7	46.1	70.4
average house sales price (1000s $)	143.6	153.1	225.1
water consumption (ccf)	15.59	15.99	17.92
lot size (1000s ft^2)	8.0	8.1	9.5
house size (1000s ft^2)	1.6	1.6	2.0
# bath fixtures	6.05	6.14	7.85
1(has pool)	0.19	0.18	0.43

Notes: Table reports means of variables. There are 133,496 SRP-eligible houses in the sample and 131,355 matched non-SRP houses in the sample.

G Robustness of the SRP Matching

This section performs several robustness checks using different approaches to matching the SRP households to non-SRP households. Recall that our primary table uses nearest-neighbor matching in which each SRP household is matched to a single non-SRP household. We present four additional approaches. The first is the same as our primary specification but using Mahalanobis matching on all the same variables (see Table A.19 for the table of balance). The second uses nearest neighbor matching to match only on Census variables (see Table A.20 for the table of balance). The third uses Mahalanobis matching to match only on variables that vary at the household level (see Table A.21 for the table of balance). The fourth uses nearest neighbor matching in which we also match on the probability of home sales in the subdivision in addition to the other variables (see Table A.22 for the table of balance). The take-away is that each of these matching approaches has a slightly different trade-off in terms of the observables included and the balance of observables.

Table A.19: Table of Balance for Matched Households: Mahalanobis Matching

	(1) SRP-eligible	(2) Matched non-SRP	(3) p-value
lot size (ft^2)	7950	7932	0.29
average house sale price	143553	144876	0.00
median household income	45662	46134	0.00
water consumption (ccf)	15.59	15.57	0.54
house size (ft^2)	1556	1557	0.69
# bath fixtures	6.05	6.06	0.35
1(has pool)	0.19	0.19	0.95

Notes: Column 1 reports means for SRP households in the water consumption data. Column 2 reports means for the matched non-SRP households, using Mahalanobis matching, in the water consumption data. Column 3 reports the p-value for a two-sided test of differences in means. Median HH income refers to the median household income at the Census block level. *** denotes significance at 1% level, ** at 5% level, * at 10% level.

The results from running each of these matching estimations are given in Table A.23. In general, we see clear evidence that the matched households exhibit a peer effect in

Table A.20: Table of Balance for Matched Households: Census Variable Matching

	(1) SRP-eligible	(2) Matched non-SRP	(3) p-value
median household income	45662	45663	0.97
median age	30.45	30.45	0.98
percentage white	56.41	56.42	0.98
percentage Latino	57.17	57.17	0.99

Notes: Column 1 reports means for SRP households in the water consumption data. Column 2 reports means for the matched non-SRP households, using nearest neighbor matching, in the water consumption data. In this table, we only match on variables that vary at the census block level. Column 3 reports the p-value for a two-sided test of differences in means. *** denotes significance at 1% level, ** at 5% level, * at 10% level.

Table A.21: Table of Balance for Matched Households: Household Variable Matching

	(1) SRP-eligible	(2) Matched non-SRP	(3) p-value
lot size (ft^2)	7950	7951	0.99
water consumption (ccf)	15.59	15.03	0.00
house size (ft^2)	1556	1556	0.99
# bath fixtures	6.05	6.06	0.98
1(has pool)	0.19	0.19	0.99

Notes: Column 1 reports means for SRP households in the water consumption data. Column 2 reports means for the matched non-SRP households, using Mahalanobis matching, in the water consumption data. This table matches only on variables that vary at the household level. Column 3 reports the p-value for a two-sided test of differences in means. *** denotes significance at 1% level, ** at 5% level, * at 10% level.

water consumption. We lose some statistical significance in some of the specifications, but all of the results are in the same order of magnitude. We view this as revealing that our main finding about the non-SRP households being different than the SRP households is robust to the exact matching approach that we use.

Table A.22: Table of Balance for Matched Households: Nearest Neighbor with Migration

	(1) SRP-eligible	(2) Matched non-SRP	(3) p-value
lot size (ft^2)	7950	8012	0.21
average house sale price	143553	143602	0.16
median household income	45662	45537	0.00
water consumption (ccf)	15.59	16.68	0.17
house size (ft^2)	1556	1525	0.38
# bath fixtures	6.05	5.92	0.07
1(has pool)	0.19	0.19	0.67
probability of home sale	0.022	0.022	0.39

Notes: Column 1 reports means for SRP households in the water consumption data. Column 2 reports means for the matched non-SRP households, using nearest neighbor matching, in the water consumption data. Column 3 reports the p-value for a two-sided test of differences in means. Median HH income refers to the median household income at the Census block level. *** denotes significance at 1% level, ** at 5% level, * at 10% level.

Table A.23: Robustness: Role of Economic Incentives

	(1) Mahalanobis Match	(2) Census Match	(3) Household Match	(4) Unmatched non-SRP	(5) Movers Match
mean peer consumption in $t-1$	0.48*	0.32***	0.48**	0.35***	0.24*
	(0.27)	(0.11)	(0.23)	(0.09)	(0.13)
Housing Market Controls	Y	Y	Y	Y	Y
Household Fixed Effects	Y	Y	Y	Y	Y
Census Block x Year Dummies	Y	Y	Y	Y	Y
First Stage F-statistic	2,429	1,686	2,096	2177	2595
R-squared	0.29	0.09	0.21	0.08	0.26
N	517,575	700,681	652,687	909,563	545,243

Notes: This table replicates column 2 of Table 6 in the main text using alternative matching routines and matching on different groups of observables. Column 1 uses the same set of variables as our primary specification in Table 6 but uses Mahalanobis matching. Column two uses nearest neighbor matching but matches only on variables that vary at the census block level. Column 3 uses Mahalanobis matching but matches only on variables that vary at the household level. Column 4 presents the results on the unmatched sample of non-SRP eligible houses. The tables of balance for each specification are presented in the three tables preceding this one and Table A.18. The dependent variable in each specification is growing season consumption in t. An observation is a household parcel-year. The peer group is defined as all houses within a 500′ radius of the household. The 'mean peer consumption in $t-1$' refers to the average peer growing season consumption in period $t-1$. All specifications instrument for peer consumption using the fraction of parcels with housing transactions within 500′ in the previous year. All models are estimated in first differences to difference out the household effects. Standard errors clustered at the Census block level. *** denotes significance at 1% level, ** at 5% level, * at 10% level.