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Using Objective Characteristics to Target Household Recycling Policies

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USING OBJECTIVE CHARACTERISTICS TO TARGET HOUSEHOLD RECYCLING POLICIES

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Household recycling is valuable because it reduces demand for virgin raw materials and lessens the cost of making products containing paper, metal, glass, or plastic. Effective recycling programs limit the amount of materials sent to landfills. Understanding the policies and contexts that are most conducive to promoting recycling can assist in the development of more effective recycling systems. It can also help businesses that are concerned with the disposition of their products and packaging. Using the most comprehensive data set on U.S. household recycling behavior, this Comment quantifies the relative impact on recycling of characteristics associated with recycling in different populations, under different governmental rules, and having different facilitating resources and amenities.

Our previous Comment in the *Environmental Law Reporter* examined trends in recycling behavior across different regions.[1] The striking result was that states that had the lowest traditional recycling rates exhibited the greatest gains. This Comment presents a deeper dive into a long-term data set on the personal, household, community, and state characteristics that are most influential, thus highlighting the relative performance of different policies as well as gaps in recycling behavior that can serve as potential targets for improvement. The depth of the analysis derives from a U.S. data set that includes more than 380,000 observations of annual household recycling behavior, based on information for more than 145,000 nationally representative households in nearly 3,000 counties across 50 states (plus the District of Columbia) spanning 10 years. The breadth of the analysis comes from many variables that reflect individual, household, county, and state characteristics.

Establishing consistent objective measures that predict household recycling provides a framework that can be directly actionable for recycling policy. Knowing the demographics of who currently recycles provides a contextual focus for education campaigns for those who do not, and for infrastructure and recycling laws that will encourage households to change their behavior. Households can be identified by their resources, housing types, and county amenities. These identifiable characteristics can be used as inputs in the design of recycling policies. By contrast, it is more difficult to design an operational policy grounded on unobservable characteristics, such as whether the household has a positive attitude toward environmental improvements, trusts government regulations, and is willing to support recycling regulations that require effort or higher taxes.

There are a number of ways that household recycling is different from other actions that increase global sustainability and cooperation in their antecedents and consequences. First, recycling is *visible*. Unlike consumption reduction and reuse, household recycling is more apparent to neighbors and can generate interpersonal praise or blame. Further, local recycling efforts can reflect positively or negatively on a town or state depending on the convenience and attractiveness of its roadside bins, collection centers, and landfill areas.

Second, recycling is *repetitive*, becoming more automatic and fluid with practice, unlike the change-then-ignore effects of the installation of solar collectors, low-energy heating and cooling, or water-saving appliances. This habitual nature of repeated recycling behaviors makes it more difficult initially, but more easily maintained once established. That inertia justifies governmental information or incentives to begin recycling.

Third, household recycling is *effortful*, making it more difficult for citizens who lack learning, space, time, or the physical ability to do the task. That effort can be reduced by local governments that provide easy labeling and frequent pickups, but those programs must tap limited local or state resources.

1. *See* W. Kip Viscusi et al., *Lessons From Ten Years of Household Recycling in the United States*, 48 ELR 10377 (May 2018).

Finally, because it is visible and can generate substantial government and citizen expense, recycling is *political*, as it affects both recycling actions and votes of citizens. Recycling can thus pit political factions espousing individual freedom and responsibility against those willing and able to support taxes and actions that increase community welfare. The fact that recycling is visible, repetitive, effortful, and political suggests that recycling can serve as a lead indicator of other sustainability actions and beliefs.

The results below derive from a regression reported in a companion working paper that includes 21 characteristics at the individual, household, county, and state levels.[2] Those characteristics are broken into between two to four levels. The resulting estimates reveal the extent to which different levels of these characteristics are predictive of household recycling. The goal is to quantify the relative contributions of 21 characteristics on household recycling. We present evidence to support the general hypotheses that physical resources and economic benefits are strongly associated with recycling for individuals, households, counties, and states.

Consider a number of the results consistent with the general hypothesis that recycling levels depend on facilitating resources and psychological motives. Greater education both increases an appreciation of the value of recycling and provides the cognitive resources that facilitate complying with specified rules. Age provides an intergenerational long-term perspective that can be reinforced by established habits of recycling. Ownership and income offer resources that facilitate recycling and motivate its local support through prospective increases in home value. Counties are better able to afford recycling amenities if citizens have high incomes and close neighbors to lower the per person cost of recycling. Finally, states with laws requiring households to recycle or demanding that counties support that effort encourage household recycling, and those efforts are more likely when motivated by a high cost of putting trash in a landfill.

It is reasonable that those who stand to gain economically or emotionally from recycling will be more likely to do so. What is surprising is that the relative effect of resources and motives differs so substantially across the 21 characteristics, enabling researchers and policymakers to focus on factors that have the greatest impact.

I. Data Used in the Analysis

The U.S. recycling data set used is from the Knowledge Networks-GfK KnowledgePanel from 2005 to 2014.[3] The household data come from annual profile surveys. Respondents took these surveys as part of their panel membership rather than for separate studies, thus avoiding possible selection effects based on the nature of a survey invitation. One identified person representing each household completed the surveys, but questions about income, family membership, and recycling reflect the household generally. The analysis merges data collected between 2005 and 2014 from more than 145,000 unique panel members providing individual and household characteristics, as well as recycling information.

Four questions from the panel surveys generate the critical recycling questions for this analysis. The question format followed the same structure for each of the four recycling materials. The question asked: "In the past 12 months, have you recycled your [material]?," where the material is indicated in different check boxes for cans, plastic, paper, and glass. We use the total number (0-4) of materials recycled in the previous 12 months as a measure of household recycling behavior. Given our focus on the effort required for household recycling, the number of materials recycled provides a general measure of the extent of recycling participation. Further, there are high correlations between the aggregate measure and the measures for the individual materials—plastic (0.89), glass (0.87), paper (0.83), and cans (0.82)—suggesting that our results would differ little if the analysis separated the four materials, as we have also shown elsewhere.

To assess the appropriateness of our measure of actual recycling, we undertook statistical tests of the relationship between the number of materials recycled and actual tonnage of recycled materials across the 72 counties of Wisconsin.[4] Counties whose respondents report a 10% higher participation on average generate 8.2% greater recycled tonnage, indicating that the surveys' reported recycling measure is a good index of actual recycling rates. In the current study, the predicted changes in recycling associated with changes in the levels of the 21 characteristics range from 2% to 22% of the average amount of 2.7 out of four possible materials recycled.

In addition to the recycling measure, the surveys provide individual and household characteristics. Individual data include age, gender, education, race, and political party identification. Household data identify type of residence, whether it is owned or rented, marital status, household income, and employment. County-level assessments of median income, population, population density, and percent white come from census data, while state-level identifiers arise from a variety of publicly available sources. The U.S. census provides information on state

2. For full details, see the technical appendix of Joel Huber et al., Using Objective Characteristics to Target Household Recycling Policies (Vanderbilt Univ. Law School Legal Studies Research Paper Series, Working Paper No. 23-36, 2023), *available at* https://ssrn.com/abstract=4536664. Other detailed explorations of these issues are reported in W. Kip Viscusi et al., *Quasi-Experimental Evidence on the Impact of State Deposit Laws and Recycling Laws: Household Recycling Following Interstate Moves*, 24 Am. L. & Econ. Rev. 614 (2022), and W. Kip Viscusi et al., *Discontinuous Behavioral Responses to Recycling Laws and Plastic Water Bottle Deposits*, 15 Am. L. & Econ. Rev. 110 (2013).

3. The KnowledgePanel is now owned by Ipsos, but that change occurred after the end date of this sample.

4. *See* Jason Bell et al., *Fostering Recycling Participation in Wisconsin Households Through Single Stream Recycling*, 93 Land Econ. 481 (2017).

population growth and spending[5] per person. Information on deposit laws is from the Bottle Bill Resource Guide,[6] and political control of the governorship and in the legislature is available from the National Conference of State Legislatures.[7] Finally, tipping fees reflecting the average cost per ton to dump in a state landfill in 2013 came from a website that is no longer available, although the Environmental Research & Education Foundation has continued to publish such estimates.

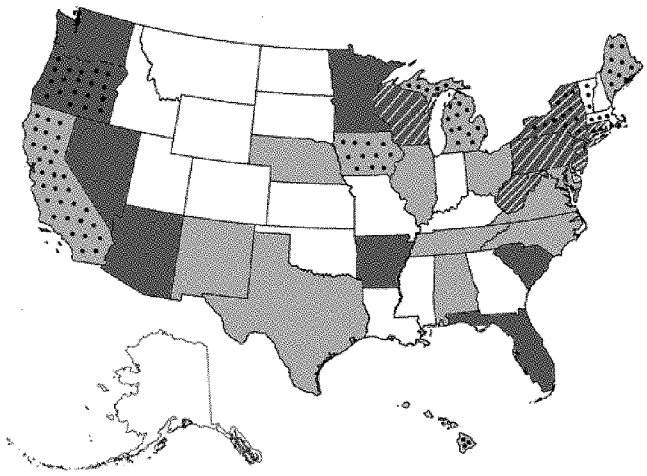
An important public policy variable builds from an analysis of the stringency of different state laws to support recycling discussed in our 2018 *Environmental Law Reporter* analysis. Figure 1 identifies states with four levels of legal intensity and deposit laws during the sample period. The strongest forms of recycling laws come from six states and the District of Columbia. These mandatory recycling laws require citizens to separate their recyclable materials from the rest of their garbage.

Another strong recycling law adopted by eight states requires municipalities to provide residents with an opportunity to recycle, which is often accomplished with services such as curbside pickup or convenient drop-off stations. Fifteen states have laws in the next tier of stringency, requiring municipalities to generate a recycling plan, but do not identify specific services. The remaining 21 states have the weakest requirements in that they either have no state recycling laws or only specify a general recycling goal without accompanying mandates.

Table A1 in the Appendix describes all included variables, providing for each the proportion of the sample in each level, along with the mean and standard deviation of its number of materials recycled. The underlying statistical analysis only includes characteristics that are strongly statistically significant ($p < 0.001$). Individual respondent information relates to education, age group, race, political party identification, and gender. Household measures assess shared resources that facilitate recycling within the household. Marriage is contrasted with those who have never been married and those whose marriage has been disrupted. A dwelling is defined as a mobile home, apartment, or house, and a separate question establishes whether that dwelling is owned or rented.

Counties are characterized by their median income, population, population density, and the percent of the population that self-identify as white. State-level characteristics are differentiated by the recycling laws discussed earlier, state spending per person, 10-year population growth, the presence of a state deposit law for beverage containers, political dominance of either Republicans or Democrats, and average landfill tipping fees per ton in the state.

Figure 1. Recycling Laws by State



Notes: States with laws that require households to recycle (dark gray with lines), require counties to support household recycling (dark gray), require counties to make recycling plans (light gray), and specify a recycling goal or have no statewide recycling laws (white). States with bottle deposit laws are marked with black dots.

II. Findings for Individuals, Households, Counties, and States

We discuss separately the individual, household, county, and state characteristics based on a statistical analysis that includes all 21 characteristics and year effects.[8] Figure 2 graphically presents the predicted effect of individual characteristics using a format that we follow throughout this Comment. The heights of bars indicate the shift in predicted recycling relative to the 2.7 average amount of materials that are recycled. The slopes of lines on the graphs reflect the predictive change in the number of materials between adjacent levels of the characteristic.

Figure 2 tells a clear story. Education is the most predictive individual characteristic. Materials recycled by those without college education are -0.30 below that of the average, rising to a discrepancy that is close to the average for those with some college education, and an increase in the number of materials recycled by +0.30 for those graduating from college or having advanced degrees. To put that result in perspective, the number of materials recycled has a shift of 0.60 across the entire span of the education levels, a 22% increase from the mean number of materials recycled of 2.7.

Other research has shown that education is consistently associated with a greater support for recycling, so the direction of the education effect is not surprising. For example, education is strongly associated with being upset from seeing a neighbor violate recycling norms, which in turn leads to greater recycling later.[9] A further mechanism generated

5. USgovernmentspending.com, *Home Page*, http://www.usgovernmentspending.com (last visited Sept. 6, 2023).
6. Container Recycling Institute, Redemption Rates and Other Features of 10 U.S. State Deposit Programs (2021), https://www.bottlebill.org/images/PDF/BottleBill10states_Summary41321.pdf.
7. National Conference of State Legislatures, *State Partisan Composition*, https://www.ncsl.org/about-state-legislatures/state-partisan-composition (last visited Oct. 2, 2023).
8. For details regarding the analysis, see Joel Huber et al., *supra* note 2.
9. *See* Joel Huber et al., *Dynamic Relationships Between Social Norms and Pro-Environmental Behavior: Evidence From Household Recycling*, 4 Behav. Pub. Pol'y 1 (2017).

Figure 2. Individual Effects Centered on the Mean of Each Characteristic

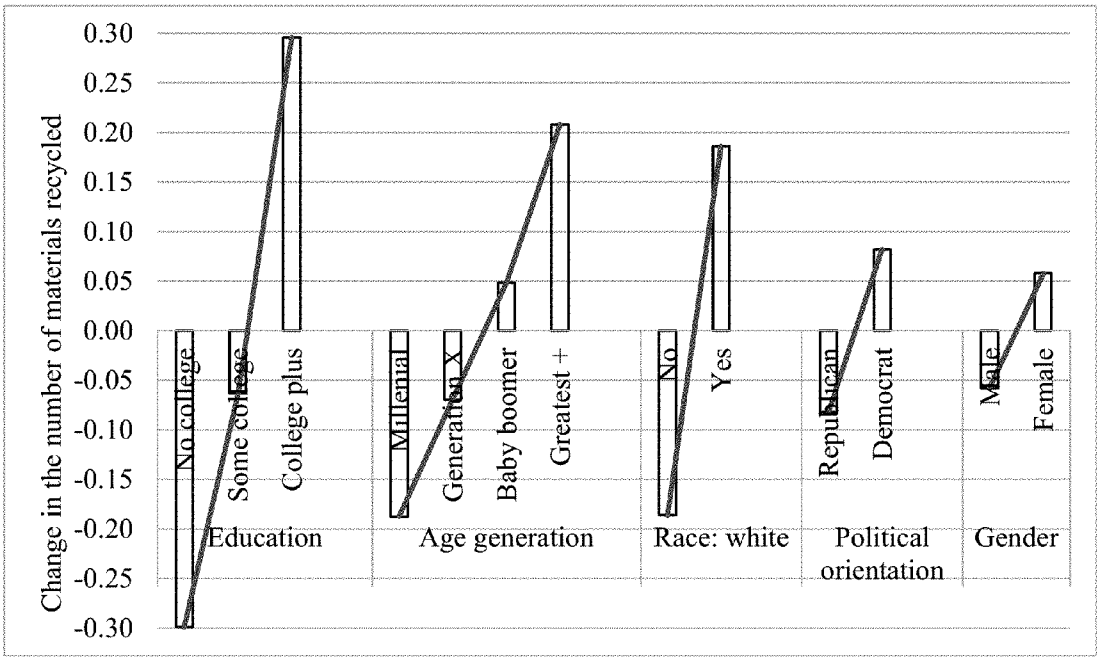
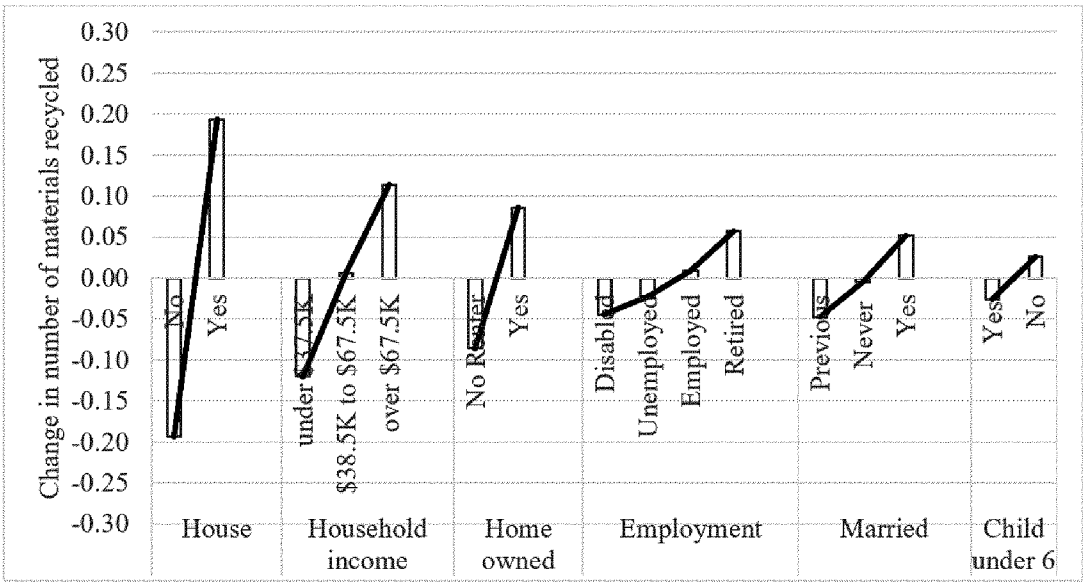


Figure 3. Household Recycling Centered on the Mean of Each Characteristic

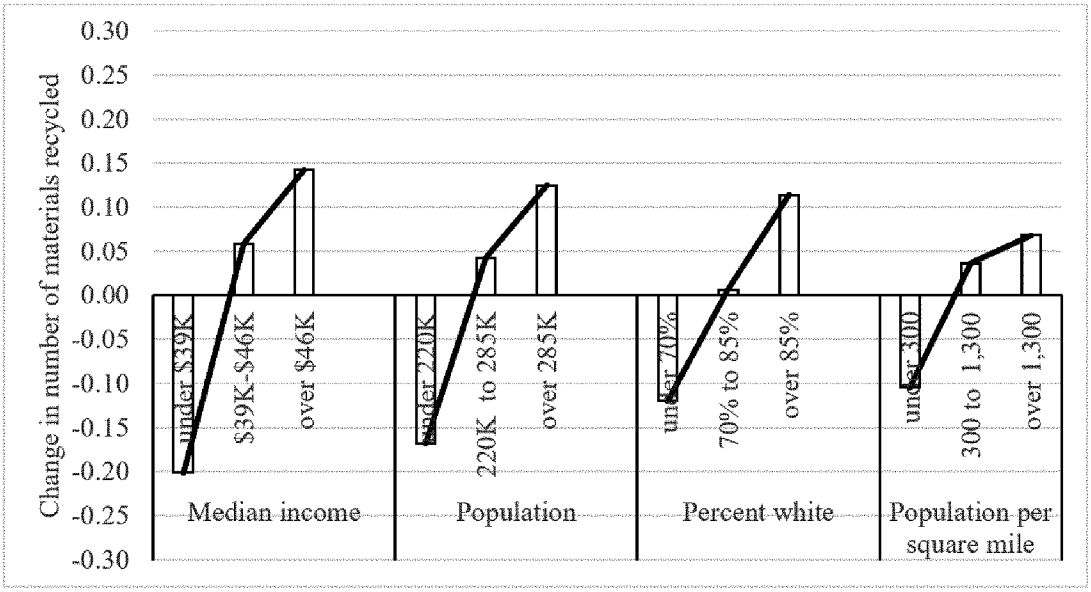


by education is that one of the best predictors of household recycling is correct knowledge of sorting rules.

Age, grouped by generational cohort (shift = 0.40), is less influential on average recycling rates than education. Millennials (born after 1980) have the lowest rate of recycling, followed by Generation X (1965-1980), baby boomers (1946-1964), and peaking with the most participation from the Silent and the Greatest Generations (born before 1946). Race (shift = 0.37), identified if the panelist self-describes as "white," has a similar impact on recycling as does age. The greater recycling among whites is consistent with the greater recycling in more affluent communities generally, which will be a recurring theme below.

Political orientation (shift = 0.16) shows that people who identify as Democrats recycle more than those who identify as Republicans. Democrats and liberals are more willing to pay for expanded recycling and support government to take recycling responsibilities on behalf of households. In all, Democrats may increase recycling both by their own direct actions and by voting for local recycling efforts. The liberal orientation that characterizes Democrats is also positively correlated with pro-environmental attitudes and

Figure 4. County Recycling Effects Centered on the Mean for Each Characteristic



behavior. Finally, females have slightly greater recycling participation than males (shift = 0.12).

Figure 3 (previous page) graphs the impacts on recycling from household characteristics. The most important predictor, housing (shift = 0.39), indicates greater recycling for respondents living in a house rather than an apartment or mobile home. Recycling requires support facilities that may be lacking or hard to use in apartments. Further, those in multifamily residences or apartments may have greater difficulty identifying who recycles, possibly limiting social pressure to recycle. Relatedly, people who own their dwellings recycle more than renters (shift = 0.17). Homeowners have a greater stake in community ecological health, possibly buttressed by a greater expected change in home equity if the community flourishes.

An important additional predictor of recycling is annual income (shift = 0.24). Employment also matters (shift = 0.10), but notice that those retired from jobs recycle more than those still employed, a result consistent with retirees having more time to recycle. Recycling also drops among those who are disabled, possibly mediated by greater difficulty lifting and sorting. Being married (shift = 0.10) is associated with greater recycling, but drops if the marriage is disrupted by separation, divorce, or widowhood. Finally, we find an increase in recycling for households that do not include a child under six years of age. This last difference is small but strongly significant, and allies with the idea that a preschool child can hinder many activities, including recycling participation.

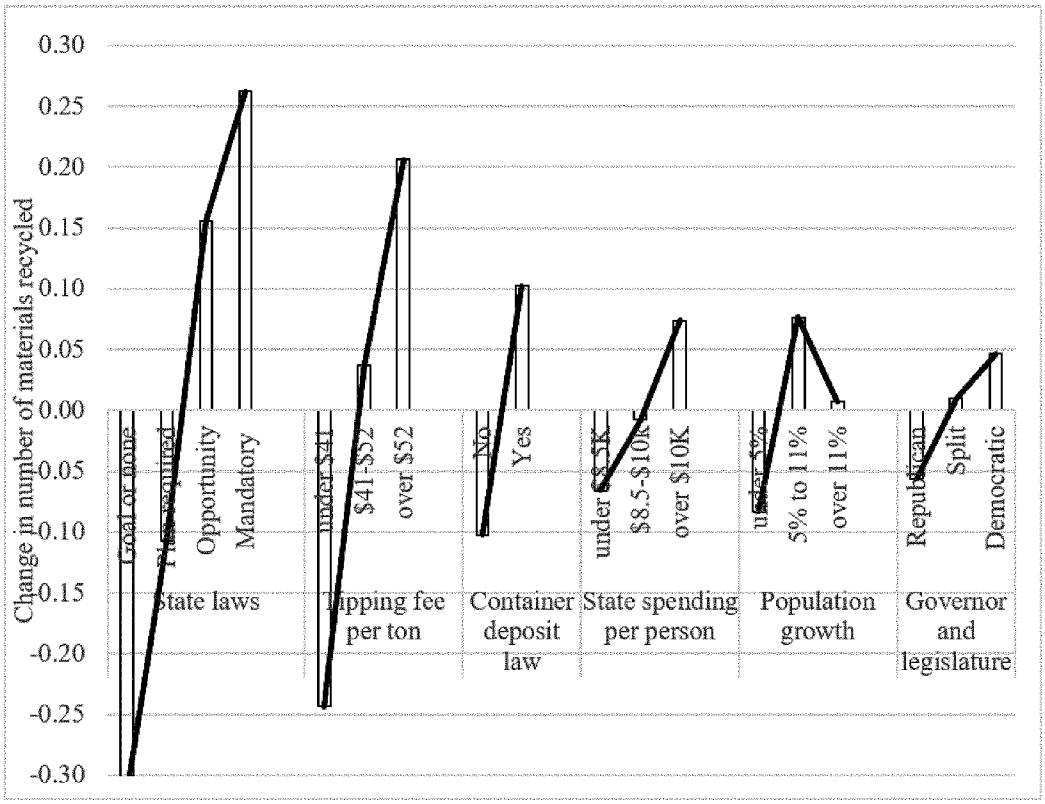
In summary, these results from individual and household survey data suggest that recycling is a task requiring knowledge about recycling, past experience with the process, along with the motivation and resources to perform the task. The impact of process knowledge is consistent with the positive effects for age and education. Greater recycling comes from those who have jobs and own homes, and are thus motivated and able to support local recycling. Factors that decrease recycling from personal challenges are most apparent for those who are disabled, widowed, separated, divorced, or have young children. These relatively small negative relationships have not often been reported elsewhere, as they are difficult to detect with fewer observations.

Next, Figure 4 graphs the effects of county characteristics on household recycling. Counties provide local support through recycling centers, home pickup, and promotional materials that simplify and encourage recycling. Counties in the top third of median incomes recycle 0.35 more materials than those in the bottom third. A combination of median county income with the 0.24 shift from individual income indicates that income combined at both levels has a substantial association with recycling.

Figure 5 (next page) displays the effects of state characteristics. Laws are the most predictive state characteristic that supports recycling (shift = 0.58). Average recycling is greatest in states that mandate citizen recycling. Next come states that require counties to offer appropriate opportunities for households to recycle, followed by those only requiring a recycling plan. The average cost to dump a ton of trash in a state landfill is also important (shift = 0.38). High fees encourage states to support the recycling of glass, paper, cans, and plastic rather than permitting their disposal in a landfill. Finally, container deposit laws for plastic, metal, or glass containers (shift = 0.26) are strongly associated with additional recycling. Deposits are also helpful in communities such as cities that generate large quantities of waste, encouraging the collection of deposit-eligible bottles and cans by those willing to salvage them, particularly in communities with few resources.

Generally, the combined positive impact of state recycling laws and container deposit laws provides important support for direct action by state legislatures to encourage recycling. These legal effects have been shown before, but

Figure 5. State Variables Centered on the Mean for Each Characteristic



not controlling for more than 50 individual, household, county, and other state characteristics. The next important characteristic is spending per person by the state government. States that spend more money per person (shift = 0.19) have the capability to commit greater resources to support households and counties in their recycling efforts.

Additionally, population growth displays a nonlinear relationship with household recycling (max shift = 0.17). Growth under 5% per decade may be a sign of less investment in infrastructure, while over 12% growth may characterize a state struggling to develop sufficient recycling infrastructure in the face of a fast-growing population. Finally, the relatively small shift of 0.07 materials for states with Democratic legislatures and governorships builds on the 0.16 shift for Democratic voters, making a general political orientation a moderate predictor of recycling.

III. Summary and Conclusions

This Comment identifies the magnitudes of 21 substantial predictors of household recycling in the United States arising from individual, household, county, and state characteristics. The richness and detail in this study would not have been possible without individual and household data from more than 380,000 observations as part of the panel surveys conducted by Knowledge Networks from 2005-2014.

Figures 2 through 5 show the expected change in recycling within each characteristic relative to the mean recycling level. We convert those measures to percentage changes for each characteristic dividing its total shift by 2.7, the average number of materials recycled. Across characteristics, education (22%) and mandatory recycling laws (21%) are most predictive, followed by age (15%), self-identifying as white (14%), living in a house (14%), tipping cost per ton (14%), living in a county with high median income (13%), a more populous county (11%), a state with deposit laws (10%), greater county percent white (9%), high household income (9%), a state with high per capita government spending (7%), a county with high population density (7%), a state with moderate population growth (6%), for individuals voting Democratic (6%), owning rather than renting their home (6%), being female (4%), married (4%), retired (4%), a state with Democratic control of the state government (3%), and not having a child under the age of six (2%).

In contrast to states with weak recycling statutes, states with laws that require citizens to recycle or counties to support their efforts see substantially greater recycling levels, demonstrating that policies and politics matter. The positive association we find between tipping fees and household recycling has economic justification. The real cost of placing recyclable waste in landfills tends to be higher where land is expensive and there are many people per square mile. Additionally, there is more recycling within states that require bottle deposits, an effect that is more beneficial in counties with low per capita income. State spending per person and Democratic state control have relatively minor, but positive, incremental effects on recycling.

The findings in this Comment provide insight into the efficacy of recycling policies as well as identifying contexts in which the greatest improvements are possible. Bottle

deposits and stringent recycling laws are potentially effective mechanisms to boost recycling. But even with such policies in place, important gaps remain.

Although this analysis has emphasized personal, social, and governmental characteristics associated with greater household recycling, the data clearly show that the converse is true. People who recycle less than average are younger, poorer, less educated, and more likely to be racial minorities. They are also more likely to live in an apartment, be unemployed, or unmarried. The counties they live in may have difficulty supporting household recycling due to less income from fewer residents, and greater per capita recycling costs due to low population density. Finally, household recycling is low in states where tipping fees are low, where political orientations and laws support individual and county autonomy, and state spending per capita and gross domestic product growth are below average.

As our 2018 *Environmental Law Reporter* piece found, the greatest gains in recycling behavior are achieved in regions where the recycling rates have been low. Accordingly, if society wants to encourage recycling across the board, greater change will occur if counties focus support for household recycling in areas with lower income and by increasing recycling requirements for rental apartments. For their part, states could provide additional resources for rural and low-income counties in return for effective recycling programs. While much research into recycling has focused on the actions of households, more attention is needed on the critical public policy roles of counties and states.

Appendix
Table A1. Variable Descriptions, Percent of Sample for Each Variable, Recycling Mean, and Standard Deviations

Variable description	% of sample	Mean materials recycled	Materials standard deviation
Education: high school or less	24.3%	2.18	1.66
Education: some college	36.3%	2.63	1.59
Education: bachelor's or more	39.4%	3.11	1.41
Age: Millennial (after 1980)	13.7%	2.28	1.68
Age: Generation X (1965-1980)	24.5%	2.60	1.62
Age: Baby boomer (1946-1964)	42.8%	2.79	1.55
Age: Silent or Greatest (before 1946)	19.1%	2.98	1.46
Race: non-white	18.6%	2.27	1.66
Race: white	81.4%	2.81	1.55
Party: Republican	44.3%	2.67	1.59
Party: Democrat	52.7%	2.76	1.57
Gender: male	39.5%	2.69	1.60
Gender: female	60.5%	2.72	1.57
Residence: apartment or mobile home	18.2%	2.26	1.67
Residence: house	80.1%	2.83	1.54
Income: $0 - $37,500	34.3%	2.27	1.65
Income: $37,501 - $67,500	31.0%	2.74	1.57
Income: $67,501 or greater	34.6%	3.12	1.41
Ownership: renter	21.3%	2.26	1.67
Ownership: owner	76.1%	2.85	1.53
Employment: disabled	5.6%	2.13	1.66
Employment: unemployed	7.1%	2.38	1.64
Employment: employed	58.5%	2.74	1.58
Employment: retired	19.8%	2.98	1.46
Relationship: formerly married	17.5%	2.59	1.61
Relationship: never married	16.2%	2.48	1.65
Relationship: married	66.2%	2.80	1.55
Yes children in home under 6 years old	12.9%	2.45	1.64
No children in home under 6 years old	87.1%	2.75	1.57
County median income 2001: less than $39k	33.3%	2.25	1.64

County median income 2001: $39k - $46k	33.4%	2.75	1.56
County median income 2001: $46k or more	33.3%	3.13	1.41
County population: less than 220,000	33.7%	2.32	1.64
County population: 220,000 - 825,000	33.2%	2.86	1.54
County population: 825,000 or more	33.0%	2.95	1.49
County population white: 0% - 70%	33.1%	2.70	1.59
County population white: 71% - 85%	33.5%	2.79	1.57
County population white: 86% or greater	33.4%	2.64	1.59
County population density: 0 - 300 per square mile	33.8%	2.35	1.63
County population density: 301 - 1,280 per square mile	33.8%	2.86	1.53
County population density: 1,281 per square mile or greater	32.4%	2.93	1.52
State recycling laws: none or goal	19.2%	2.24	1.65
State recycling laws: plan	46.4%	2.65	1.58
State recycling laws: opportunity	17.8%	2.90	1.53
State recycling laws: mandatory	16.5%	3.22	1.36
State landfill tipping fee: $24.29 - $41.15	31.4%	2.16	1.64
State landfill tipping fee: $41.59 - $50.20	32.6%	2.71	1.60
State landfill tipping: $52.07 - $91.00	36.0%	3.19	1.34
State has no deposit law	71.1%	2.53	1.64
State has deposit law	28.7%	3.15	1.35
Population change: negative or up to +5%	33.5%	2.80	1.57
Population change: +5% to +11%	33.4%	2.84	1.52
Population change: +11% or more	33.2%	2.49	1.63
State: Republican governor and legislature	34.5%	2.39	1.65
State: split governor and legislature	35.4%	2.75	1.56
State: Democratic governor and legislature	30.1%	3.02	1.45
State government spending: $6k - $8.5k	34.0%	2.34	1.65
State government spending: $8.5k - $10k	32.7%	2.66	1.60
State government spending: $10k or more	33.3%	3.13	1.38

Date: 2005	8.4%	2.49	1.65
Date: 2006	5.6%	2.52	1.63
Date: 2007	10.2%	2.69	1.59
Date: 2008	3.6%	2.69	1.57
Date: 2009	10.5%	2.80	1.55
Date: 2010	13.3%	2.75	1.57
Date: 2011	10.7%	2.79	1.56
Date: 2012	12.8%	2.73	1.57
Date: 2013	14.8%	2.73	1.56
Date: 2014	10.1%	2.75	1.59

Notes: N = 383,571. Total number of materials recycled: mean = 2.71; standard deviation = 1.58. Dollar, percentage, population, and density category variables each cut off at the precise high end of its category, and begin at any value above the high end of the previous category. There is no overlap of any categorical data, since no observation had a value at the precise start or end point of any category split except tipping fee.