DETERMINANTS OF THE USE OF LOW-FLOW FIXTURES IN APARTMENTS IN AN ARID CLIMATE

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Abstract

The purpose of this study is to analyze the determinants of employing low-flow water fixtures in apartments in order to conserve interior water use. The fixtures are low-flow showerheads, faucets and toilets. Ranked probit analysis is used to explain the presence of each of these fixtures in all, some or none of the apartment units within each complex. The demand for water conservation is derived from both the firm's efforts to cost minimize and consumers' desires for water-related services subject to their prices. The results show that the economic variables do not affect the use of low-flow water fixtures. Their use is more related to other water policies used in the complex, attitudes of tenants, apartment size and characteristics of the staff and manager.

INTRODUCTION

Water supply and quality are of increasing concern in the U.S. and in many other parts of the world. Maintaining adequate water supplies in the face of growing population and rising standards of living is particularly problematic for Western states. Individual apartment complexes use far more water than single family residences but may be considered to operate as a case of market failure because tenant demand for water is unrelated to price. This is because (with rare exceptions) tenants do not pay their own water bills directly. Constraints to water use may be provided by the apartment ownership and/or management in their attempts to minimize costs or by ecological consciousness of the tenants.

Little or no research has focused on water conservation in the rapidly growing number of apartments although previous studies have examined water conservation of residential consumers living in detached dwellings. To meet water conservation goals, however, municipal providers will be forced to find ways to encourage conservation in apartments.

The purpose of this study is to analyze the determinants of one method of conserving interior water use in apartments, the use of low-flow water fixtures. The fixtures are low-flow showerheads, faucets and toilets. Ranked probit analysis is used to explain the presence of each of these fixtures in all, some or none of the apartment units within each complex.

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MODEL OF ADOPTION

We posit that conservation is a process that occurs over time and can be effective in curbing the demand for water in apartments. Evidence for the latter assumption comes from numerous studies showing that the demand for residential interior water use is somewhat price elastic (e.g., Howe and Linaweaver, 1967). Water-saving features may be adopted when apartments are built or retrofitted all at once or gradually over time as the apartments are remodelled or refurbished. Thus the dependent variable in this study measures whether none, some or all of the apartments in the complex have water-saving fixtures.

Toilets, showerheads and faucets account for approximately 75% of interior water consumption in the home and water consumption declines in the order stated (Winkler, 1982). Use of water-saving toilets or toilet tank displacements, low-flow showerheads and faucets are estimated to save 50 percent or more of water consumed by ordinary fixtures (Javits, 1979).

The demand for low-flow fixtures in apartments is derived from the firm's goals of minimizing cost and maximizing profit by providing a service demanded by consumers. This implies a balance between expected savings in water bills and the extra costs of the fixtures and their installation. Other costs include those of additional maintenance over time and increased numbers of tenant complaints. Furthermore, the efforts to minimize costs must be weighed against the potential effect on demand for the apartments. Considering the importance of such factors as the prices of complements (e.g., travel to work and recreation), the price of the space and significant amenities, however, the demand for apartments would be only slightly influenced by consumers' preferences regarding low-flow fixtures.

The demand by consumers, in this case tenants, for low-flow features in apartments is influenced by whether they pay directly or indirectly for water. For those who pay indirectly for water, tenants' demand for low-flow fixtures would be derived by the desire to minimize apartment rent. This would especially hold if the price of water were a significant percentage of the rent. However, because the price of water is usually so nominal that it comprises a small fraction of the rent, its influence may be entirely overlooked by tenants who pay indirectly. On the other hand, if the tenant holds strong preferences for conserving water because of environmental or other concerns, she/he would have a derived demand for low-flow fixtures to help achieve his/her environmental objectives.

In apartments that charge directly for water, tenants have the incentive to provide low-flow fixtures themselves or request them from the landlord.

Furthermore, landlords would have greater incentive to install them to attract cost-conscious tenants and would receive fewer complaints about them. Tenants would have the incentive to help maintain them and thus would lower maintenance costs to landlords as well.

TABLE 1. Sample Characteristics, N=409

Variable	Definition	Mean or Percent	Expected Direction
Economic incentives for retrofitting			
TENPAY	Apartment charges tenant for water directly (0,1)	4.2%	+
PRICE	High and low marginal price (0,1)	1.7%	-
Apartment Complexes			
NTOTAPT	Size of complex in number of units	73.94	+
Manager's Conservation Practices			
LEAKCK	Frequency with which staff checks leaks	5.76	+
CARWASH	Complex permits car washing on premises (1,0)	25.7%	-
INFORM	Efforts made by the complex to inform tenants about water use	1.38	+
Non-economic constraints to retrofitting			
GRIPE	Tenants complain about low-flow fixtures (1,0)	9.3%	+
Factors Affecting Cost of Retrofits			
REMODEL	Apartments have been remodeled in last few years (0,1)	17.1%	+
MGRFULL	Manager works at complex full-time (1,0)	61.4	+
MGRRES	Manager resides in complex (1,0)	55.3%	+
MGRHLP	Size of support staff	1.25	+
Managers or Owners			
MGREDUC	Manager's level of education	5.77	?
MGRAGE	Age of manager	44.12	+

The literature on consumers' adoption of water-saving and energy-saving retrofits indicates that a variety of factors influence the process. We assume they also influence the adoption by apartments because adoption is derived both from consumer demand and the firm's desire to minimize production costs. Thus we hypothesize that the adoption of water-saving retrofits in apartments will be determined by benefits and costs that are important to consumers as well as landlords. The list of independent variables and their hypothesized direction of effects is shown in Table 1.

Benefits of making low-flow retrofits include direct economic incentives to the landlord and/or tenant. Other influences on water use include characteristics of the apartment complex, proclivity of managers or owners to conserve, and tenant preferences for low-flow fixtures.

Direct economic incentives are measured by two dummy variables. The first measure of economic incentives to conserve indicates whether tenants pay directly for their water consumption (coded 1 for direct payment). The second variable signifies high and low water rates, reflecting the two water districts comprising the sample (coded 1 for the lower rate). The rates in the larger district are much higher than those in the smaller area. Use of low-flow fixtures is expected to rise with each of these variables.

The size of the complex, measured by the total number of apartments, is used to proxy other water-using characteristics of the complex and thus is expected to be positively related to the use of low-flow fixtures. Complex size is collinear with such variables as type of landscaping and number of swimming pools, two variables that are extremely salient in determining water use. The landlord's proclivity to conserve is measured by three variables: 1) Allowing car washing on the premises; 2) degree of checking for leaks; and 3) degree of information about water conservation provided by landlords to tenants. Car washing is expected to be negatively associated with and the other two positively related to the use of low-flow fixtures. Tenant preferences for low-flow fixtures are measured by managers' reports that tenants complain about low-flow fixtures. The likelihood of tenant complaints will rise with fixture use.

Costs of retrofitting constrain efforts to conserve. These are proxied herein by two factors. The first factor is whether the complex has been substantially remodelled in the previous few years. The second factor is labor availability. This is indicated by whether the manager works at the complex full- or part-time, the number of support staff, and whether the manager resides on the premises. Each of these is expected to increase the use of low-flow fixtures.

The characteristics of the landlord are considered to be facilitators which better enable her or him to perceive the range of relevant benefits, costs, and discount rates (Hausman, 1979), and to derive methods for acting on the results of the decision to invest in water-saving equipment. These include the number of years of education and the age of the manager. The effect of education is not predicted because of the ambiguity of findings in the literature (e.g. Cunningham and Lopreato, 1977; Hamilton, 1983). Counter to previous findings with respect to age, the use of water fixtures is posited to rise with age because older landlords have had more time to retrofit gradually.

PROCEDURE

Analysis

Ordered probit analysis was used to evaluate the impact of the explanatory variables on the dependent variables, uses of low-flow fixtures (defined in Table 2). Ordered probit analysis was used because each of the three dependent variables, use of low-flow showerheads, faucets and toilets, has three ordinal level categories: use in none, some or all of the apartments in each complex (Hanushek and Jackson, 1977).

TABLE 2. Dependent Variables

Variable	Definition	Percent
SHWRNONE	No units have water-saving showerheads (1,0)	44.8%
SHWRSOME	Some units have water-saving showerheads (1,0)	20.2%
SHWRALL	All units have water-saving showerheads (1,0)	35.1%
FAUCNONE	No units have water-saving faucets (1,0)	64.1%
FAUCSOME	Some units have water-saving faucets (1,0)	13.0%
FAUCALL	All units have water-saving faucets (1,0)	23.0%
WCNONE	No units have water-saving toilets (1,0)	68.7%
WCSOME	Some units have water-saving toilets (1,0)	7.4%
WCALL	All units have water-saving toilets (1,0)	24.0%

Data and Sample

The units of analysis are apartment complexes and their managers or owners. These data were collected as part of a larger project to assess the determinants of water demand in apartments. Consumption data and a sampling frame of apartment complexes were provided by the primary water utility in Tucson, Arizona. We employed stratified random sampling to oversample larger complexes and those in low and high income census tracts. All of the apartments in a small, but growing, cooperative water district were also included in the sampling frame. Telephone interviews were conducted in October 1988 with managers or owners of the sample apartments. This produced 409 completed interviews over a two week period which amounts to a 69% response rate. The response rate seemed to have been boosted by the incentives offered because the interviews ranged between approximately 20 and 40 minutes each. The incentives were department store gift certificates purchased with project funds and dinners-for-two donated by local restaurants. Approximately 1 percent of the owners/managers received these gifts. The content validity of the questions on the survey was evaluated with a review of literature, peer review, review by the grantor, local water resource experts and finally, field tests of apartment managers and owners.

General Description of Apartments, Landlords and Tenants

Apartments

The complexes range from 2 to 500 units. Approximately 26% of the sample complexes contain fewer than 10 apartment units; 34% have 10 to 49 units; 13%, 50-99 units; and 27%, between 100 and 500 units. The apartments tend to be small; the most common apartment size (1/3 of the sample) is three rooms, (excluding bathrooms, porches, balconies, foyers, halls, half-rooms and storage areas). Twenty-nine percent had 4 rooms while 20% had only two. The remainder have 1, 5, or 6 rooms. Seventy-four percent of the sampled apartments have one bathroom, while another 18% have 2 bathrooms.

Very few of the apartments in the sample charge tenants explicitly for water, and even fewer report individual unit water meters. Ninety-six percent of managers report that tenants do not pay individual water bills, and only 2% report that apartments are individually metered.

Landlords

Managers comprise 62% of the sample, owners 29%, and others (such as owner's or manager's spouse), 9%. The majority of owners (58%) have owned their apartment complex for less than ten years. When managers were asked about their authority to make water-saving investments in their apartments, 18% of the 256 who responded stated that they could proceed without specific owner consent, another 22% reported that they could proceed if the cost were low, while the remaining 61% indicated that specific owner approval would be required.

Almost 2/3 of the managers work at the complex full-time, while 20% manage more than one apartment complex, and 20% work at another job in addition to apartment management. Staff size averages 1.25. Living in the apartment being managed is likely to provide more manager presence, and the potential for more conservation-oriented management. Fifty-five percent of the managers live in the complex.

The largest group of managers has some college education, while the second and third largest groups have graduated either from high school or college. Manager's ages cover a wide span, from 19 to 86 years. Forty-five percent are age 19 to 40, and 40% are 41 to 60. Most of the managers are female (63%).

Tenants

While the units of analysis in this paper are the apartment complexes and their owners/managers, the tenants are described herein to provide context. The typical tenant had lived in the same apartment for a year or less, yet some tenants reported having lived in the same location for as long as 23 years. They have resided in the State for 5 years and consider themselves permanent residents of Tucson. Only 9% of the respondents are winter visitors while 19% are students. Respondent ages ranged from 17 to 96, with

a median age of 31. Forty-one percent of the respondents report working full-time, 16% are retired, and 16% are students. Forty-four percent had completed some college, 16% had graduated each from high school and college. Nineteen percent reported having done some graduate work or having completed a graduate degree.

The survey included tenants with a wide range of incomes; median household income ranged between $13,000 and $16,000. Monthly rents ranged from zero (some tenants worked for their rent) to $1650 per month, with a median rent of $340. Only 5% of the respondents report paying for water, while 21% pay for natural gas and 80% pay for their own electricity.

RESULTS

The model explains a statistically significant percentage of the variance in all three of the dependent variables: use of water-saving showerheads, faucets, and toilets. This is indicated by the chi square statistics (Table 3). The rho statistics range between .069 and .072, which indicate that the model fits nominally considering that an excellent fit is implied by values between .2 and .4 (Hanushek and Jackson, 1977).

Benefits

The measures of direct economic incentives, whether or not tenants pay directly for their water and the price proxy, are not statistically significant determinants of the use of low-flow showerheads, faucets or toilets (Table 3).

Complex size is positively and significantly related to use of low-flow showerheads and approaches significance ($p \leq .11$) on the other fixtures. The marginal effects suggest that smaller complexes are slightly more likely to have no water-saving showerheads. The results depend upon the statistic used to calculated the average, however. In one case we used the mean and in another, the median, because the mean was skewed to the high end of the distribution. Across all fixtures, use in small complexes reflects that of the median-sized complex but shows that the probabilities for all or no use vary from that for the mean-size apartment complex. For example, the probability that the mean-size complex uses no low-flow showerheads is .44 versus .48 and .41 for small and large complexes, respectively. The probability of the average-size complex using no low-flow faucets is .65, versus .68 and .63 for small and large complexes with no low-flow faucets. The probability of no water-saving toilets for the mean sized complex is .71 compared to .67 and .74 for small and large complexes, respectively.

Managers' attempts to conserve are posited to reflect a conservation orientation. The results of the individual measures of conserving are ambiguous, however. Of these three variables, permission to wash cars has the most consistent effect. Those who allow car washing are less likely to use water-saving showerheads and faucets than those disallowing on-site car washing. Those purporting to check leaks most often are more likely to use low-flow showerheads but are less likely to have low-flow faucets. Neither checking leaks nor washing cars is related to the

TABLE 3. Results of the probit analyses

Independent Variables	Showers Coef	Showers t[a]	Faucets Coef	Faucets t	Toilets Coef	Toilets t
TENPAY	-0.647	-1.424	-0.045	-0.102	-0.443	-0.942
PRICE	-0.399	-0.808	-0.627	-0.796	0.753	1.457
NTOTAPT	0.002	2.095 **	0.001	1.574	-0.002	-1.560
LEAKCK	0.048	2.126 **	-0.063	-2.609 ***	0.014	0.556
INFORM	0.035	0.973	0.007	0.201	0.067	1.769 *
CARWASH	-0.388	-2.421 **	-0.399	-2.263 **	-0.080	-0.418
GRIPE	0.438	1.628 *	0.248	0.966	0.032	0.105
REMODEL	-0.054	-0.300	-0.196	-1.047	0.176	0.881
MGRFULL	0.168	0.982	0.345	1.776 *	0.218	1.101
MGRHLP	-0.079	-0.807	-0.187	-1.762 *	0.036	0.340
MGRRES	0.358	2.380 **	0.173	1.052	0.496	2.871 ***
MGREDUC	-0.012	-0.272	-0.092	-2.030 **	-0.012	-0.258
MGRAGE	0.005	0.946	0.007	1.303	0.015	2.558 **
INTERCEPT 1	-0.547	-1.189	0.151	0.311	-1.655	-3.181 **
INTERCEPT 2	0.604	9.260 ***	0.399	6.427 ***	0.258	5.199 ***
Chi Square Statistic	52.37 ***		43.24 ***		38.04 ***	
Rho (Pseudo-R^2)	.072		.070		.069	

*Significant at 0.10 level
**Significant at 0.05 level
***Significant at 0.01 level
[a]These are asymptotic t-ratios.

presence of low-flow toilets but those who claim to inform tenants about saving water are more likely than others to have them.

Apartment complexes with managers who have an average orientation toward conserving have 44, 24 and 33 percent of the apartments with none, some and all water-saving showerheads. Whereas those in which tenants are not allowed to wash cars, leaks are checked most regularly and which provide information about saving water, have only 23 percent with no low-flow showerheads, 22 percent with some and 55 percent with total coverage. In contrast, non-conservers have 68, 18 and 14 percent with none, some and total coverage.
Those with a conservation orientation are less likely to have no low-flow toilets (50%), more likely to have some (10%) or total coverage (39%) than the average complex (71%, 8%, and 21%). They were also more likely to have water-saving toilets than those with lax rules and operations.

Complexes with tenants who complain about low-flow fixtures are more likely to have installed low-flow showerheads in their apartments than those not reporting tenant complaints. Tenant complaints are unrelated to use of faucets and toilets, however. This pattern coincides with analyses of tenant reports from the larger dataset which show that of the interior low-flow features, tenants are least satisfied with low-flow showerheads.

Costs

Factors affecting costs of retrofits, whether apartments had been remodeled and staff capabilities, had mixed effects. Remodeling was not significant in any of the equations. If the manager resides in the complex the use of all types of conservation devices is likely to be higher than if she or he does not. Residence is significant only for showerheads and toilets, however.

Complexes with managers working full-time and larger staffs were posited to have better coverage of water-saving devices than those with part-time managers and smaller staffs. Indeed, the effect of the full-time variable was positive across devices but significant only for faucets. The staff variable was significant for faucets also, but the effect was negative. These two variables may be picking up some of the effect of apartment size. However, the tendency for complexes with smaller staffs to conserve may reflect a strong disposition toward cost minimization on the part of the owners of small and medium-sized apartments.

The marginal effects show that the probability of using low-flow faucets was the same in complexes with full-time managers, the largest staffs and managers-in-residence as those in complexes with the opposite staff characteristics. The probability of having full use of water saving showers and toilets did increase, however, from .25 and .10, respectively for those with less management presence to .36 and .33 for those with maximum presence.

Facilitators

The manager's or owner's personal characteristics also have some influence on the use of water-saving features. As years of education decline use of water-saving fixtures increases, although only low-flow faucets were significant. Use of water-saving toilets increased significantly with managers'/owners' ages and the effect for the other fixtures was also positive.

An increase of one standard deviation in managers' ages increased the probability of using all types of water-saving devices, while a similar decrease caused a drop in these probabilities. The probabilities of not using low-flow showerheads, faucets, or toilets increased from .41, .62 and .63 for the older managers, to .46, .69 and .78, respectively, for the younger managers.

CONCLUSIONS

Conservation of water in arid regions has depended largely on economic incentives. These results suggest, however, that water prices are too low to effect the use of water-saving fixtures in apartments and thus need to be raised. Alternatively, these findings also imply the necessity of employing incentives other than price in order to produce desired levels of conservation by apartment managers and tenants.

Water conservation policies of apartment complexes seem to be interrelated. For example, car washing was more likely permitted in apartments with fewer low-flow fixtures. Thus water utilities could set a goal to encourage apartments to begin conserving with some assurance that preliminary efforts would spawn further conservation.

The limited types of tenant complaints about low-flow fixtures implies that tenants generally accept them. Use of low-flow showerheads would probably be more successful if managers informed tenants about how to clean them and if the staff also cleaned them during routine maintenance.

That older managers or owners are more likely to use water-saving features than their younger counterparts may reflect the length of time over which they've been able to make gradual capital improvements, or greater environmental awareness. It may also result from the large number of college students managing apartments who concentrate on their studies rather than on maintenance. This suggests that high-cost compared with low-cost managers (older more experienced people versus students) may actually be less expensive than they appear because the extra effort they invest in their jobs helps to minimize costs, including water bills.

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