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No Dog Left Behind: A Hedonic Pricing Model for Animal Shelters

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ABSTRACT

Companion animal overpopulation is a growing problem in the United States. In addition to strays, an average of 324,500 nonhuman animals are relinquished to shelters yearly by their caregivers due to family disruption (divorce, death), foreclosure, economic problems, or minor behavioral issues. As a result, estimates of animals in shelters range from 3 million to 8 million, and due to overcrowding, euthanasia is common. This analysis seeks to determine the appropriate pricing mechanisms to clear animal shelters of dogs in the manner most desirable—that is, through adoption. Based on a survey of Michigan residents, it is clear there are a number of correlations between the traits of dogs and the individuals who care for them. Hedonic pricing models indicate that animal shelters need to proactively vary their pricing systems to discount particular traits, specifically for mixed-breed, older, and black dogs. Premiums can be charged for puppies, purebred dogs, and those who have received specific services such as microchipping.

KEYWORDS

Shelter animal pricing; hedonic pricing; companion animal traits

Companion animal overpopulation is a growing problem in the United States; the average fertile dog produces one litter with an average of four to six puppies annually, for example. Given that there are an estimated 70 million stray cats and dogs in the country and that only 10% of nonhuman animals received by animal shelters are spayed or neutered, the potential for animal overpopulation is extreme (American Society for the Prevention of Cruelty to Animals [ASPCA], 2015b). In addition to strays, an average of 324,500 animals are relinquished to animal shelters yearly by their guardians due to family disruption (divorce, death), foreclosure, economic problems, or minor behavioral issues. As a result, estimates of animals in shelters in the United States range from 3 million to 8 million (Best Friends, 2015). Because there are only an estimated 13,600 community animal shelters in the United States, euthanasia due to overcrowding is common; estimates of animals euthanized in shelters annually vary widely from 4 million to 17 million (ASPCA, 2015b; Bartlett, Bartlett, Walshaw, & Halstead, 2005). Based on data from the Best Friends animal rescue, more than 7 animals are euthanized per minute, or 9,000 per day. More specifically, about 60% of dogs admitted to animal shelters are euthanized.

Although there are no general estimates on the average length of stay for animals in shelters, if a facility is overcrowded, longer stays imply a higher likelihood of being euthanized for individual animals. It seems clear that getting as many dogs adopted from shelters as quickly as possible is critical to reducing the rate at which dogs are euthanized. This need is essential from a humane perspective, but it is also essential to making shelter resources available to as many animals as possible. It has been estimated that $2,400 million of public funding was spent on shelters in 2007 and that communities across the United States spend about $8 per capita on shelters (Humane Society of the United States, 2015). Given the fact that many severely distressed cities such as Detroit and New Orleans have increasing numbers of roaming dogs presenting health and safety risks to humans and other animals

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including wildlife (Reese, 2015), the public policy implications of animal shelter practices and capacities are clear. Thus, this research asked a simple question: What pricing system is most likely to get dogs adopted from shelters as rapidly as possible? The central hypothesis was that there is a systematic and measurable relationship between acquisition costs and dog characteristics. In other words, the analysis sought to determine the appropriate pricing mechanisms to clear animal shelters of dogs in the manner most desirable—that is, through adoption.

Value of companion animals

Companion animals, and specifically dogs, play dual roles in households and simultaneously function as objects and individual, dependent beings (Sanders & Hirschman, 1996). Given the multidimensional economic and emotional relationship between dogs and humans, it is unsurprising that research on dog ownership crosses disciplinary lines and includes a wealth of investigation on the physical, psychological, and social benefits associated with having a canine companion in the household. Empirical work analyzing the process by which people choose their companion animals, particularly the role of purchase and maintenance costs, is less common. Taken together, this combined body of literature can be used to help identify factors that influence consumers (dog owners, guardians/caregivers) as they make choices about their companion animals.

To estimate how dog guardians might respond to price differentials, it is important to first understand the components that capture the breadth of extrinsic and intrinsic values in the consumption process—namely, the characteristics of dog guardians, the characteristics of dogs whom they prefer to acquire, and the costs and benefits of dog ownership. Dog caregivers are more likely to have higher-than-average incomes (Dotson & Hyatt, 2008; Marston, Bennett, & Coleman, 2005). Ownership is also associated with certain stages of the family lifecycle, in particular, when people do not have very young children (Albert & Bulcroft, 1987; Bulcroft, 1990). Women report higher levels of dog caretaking and companionship than do men, and there is some evidence that they are more influential on children's attitudes toward companion animals (Albert & Bulcroft, 1987; Dotson & Hyatt, 2008). Dog guardians are also highly likely to have had companion animals as children (Marston et al., 2005).

Much of the research on the preferred characteristics of companion dogs focuses on guardian perceptions of dog adoptability rather than empirical data from actual adoptions. The characteristics of guardians themselves may also influence desired dog characteristics, with younger individuals preferring dogs perceived as aggressive (though in spite of popular notions, caregivers preferring aggressive dogs exhibited no more delinquent or aggressive behavior than those who prefer less aggressive dogs; Egan & MacKenzie, 2012). People report choosing their dogs for behavioral, size, and appearance characteristics (Marston et al., 2005; Weiss, Miller, Mohan-Gibbons, & Vela, 2012). Friendly, calm, and submissive dogs are viewed as more adoptable (Wells & Hepper, 1992; Wright, Smith, Daniel, & Adkins, 2007).

Decisions and perceptions based on appearance are complex, and recent experimental research has suggested that *black dog syndrome*—the disproportionate failure of black dogs to be adopted—may capture attitudes toward more than coat color, as respondents make judgments about adoptability based on characteristics they associate with breeds rather than the color of a dog's coat or the creature's size (Svoboda & Hoffman, 2015; Woodward, Milliken, & Humy, 2012). Some analyses of shelter adoptions have showed no difference in adoption rates between lighter and black-coated dogs (Brown, Davisdon, & Zuefle, 2013; Svoboda & Hoffman, 2015), while others have placed a higher importance on coat color and overall appearance (Lepper, Kass, & Hart, 2002; Posage, Bartlett, & Thomas, 1998).

Studies of retention of dogs in the homes to which they are adopted offer other indications about preferred characteristics and the influence of price on guardian behavior. Patronek, Glickman, Beck, McCabe, and Ecker (1996) found that higher prices discouraged guardian relinquishment of adopted dogs and that dogs who received more veterinary care and obedience training classes were more likely to have successful adoptions. For example, dogs who attended socialization classes, were female, wore head collars, and were placed in homes without young children were less likely to be returned to adopting agencies (Duxbury, Jackson, Line, & Anderson, 2003). Guardian relocation is the other primary reason

for animal relinquishment (Marston et al., 2005; Patronek et al., 1996; Salman et al., 1998). These results suggest that stable living environments and preadoption education to minimize behavioral problems, along with prices, are characteristics that produce more successful dog placements.

The benefits of dog ownership are, of course, accompanied by costs. The average cost of acquisition was reported to be $48.75 in 1995–1996 in a nationally representative sample of shelter adopters (Salman et al., 1998). First-year dog maintenance costs as estimated by the ASPCA range from $1,214 to $1,843 depending on the size of the dog (ASPCA, 2015a). Veterinary costs and high-dollar services are increasingly available, yet there are no consistent data on the details of those costs or their impacts on individual dog guardians.

Contributions of hedonic pricing models

While the research just discussed tends to value dogs in psychological or health terms, economists typically characterize the price of a good or service as being related to the characteristics (or attributes) embodied in that good or service, and they sometimes use hedonic modeling approaches to estimate the "implicit prices" of those various characteristics. Potential dog owners make choices based on a variety of attributes of the dog including size, breed, appearance, and purpose. Consequently, if potential adopters have a strong preference for or aversion to certain characteristics, they may be willing to pay more or less to obtain a dog with those characteristics.

Hedonic pricing models have been used in a variety of situations to explore the market values for goods and services using observations of the price of the overall good or service to obtain implicit prices for individual components and estimate the willingness to pay for specific product characteristics (Rosen, 1974). Hedonic pricing has perhaps been used most extensively in housing markets to evaluate willingness to pay for characteristics embodied in a home (see, e.g., Boyle & Kiel, 2001; Sirmans, Macpherson, & Zietz, 2005).

There is also a large literature base that has examined various forms of discrimination in the labor market, specifically the roles that race, ethnicity, gender, age, disabilities, obesity, and even beauty play in wage determination (see Cain, 1986, for a review of this literature). The methodology has also been applied in novel ways to determine optimal pricing for such intangible goods as the adoption of children (Skidmore, Anderson, & Eiswerth, 2014). And although children and dogs are both living "products," hedonic pricing models have been used widely and effectively to allow for the pricing of such intangibles as personal beauty, racial characteristics, happiness, life satisfaction, the taste of grapes, the "luckiness" of potential properties, and the cost of human lives (Chau, Ma, & Ho, 2001; Riera, Mhawej, Mavsar, & Brey, 2006; Van Praag & Baarsma, 2005). Thus, "while it is somewhat unconventional to think of the adoption choice as being made in a 'market,' such a framework may be useful for understanding parental and professional behavior and human services policymaking" (Skidmore et al., 2014, pp. 1–2).

We assert that the marketplace is where dog ownership decisions are made. Dogs, like goods and services, embody a set of characteristics. Potential dog guardians express their preferences for particular characteristics, and some dog caregivers are willing to pay more to obtain a dog who embodies the desired traits. One limitation of this approach is that some dog characteristics are not quantifiable; nevertheless, many characteristics are measurable. The hedonic method evaluates willingness to pay for these measurable attributes. Another limitation is that the process of allocating dogs to potential dog guardians may contain elements other than price. For example, a family may adopt a neighbor dog who for some reason has been abandoned. In such a case, emotional connections may outweigh other factors. Our empirical approach will reveal the degree to which market forces determine prices.

The use of hedonic pricing models in the case of dog adoptions can provide information that will allow animal shelters to establish pricing systems to *proactively* discount particular, less "valuable" traits so that they do not need to resort to *reactive* price reductions when the stock of certain types of dogs gets too high. This pricing should thus reduce the time to adoption and the risk for euthanasia for such dogs if they are priced more effectively at the outset of their shelter stay.

Materials and methods

Michigan shelter context

Michigan had just fewer than 200 licensed animal shelters in 2014. Research conducted on annual shelter reports in 2003 indicated that these shelters released 140,653 dogs; 56,972 or 40% of these dogs were euthanized while 28% or 40,005 were adopted. (The rest of the dogs were released to their guardians or were transferred to other shelters or rescues; Bartlett et al., 2005). To provide perspective, these numbers mean that 1 dog was euthanized for every 174 persons in the state. The total number of animals euthanized in Michigan shelters in 2013 was down to 42,852 (Michigan Pet Fund Alliance, 2013; numbers for 2013 include all types of animals).

While some shelters in Michigan do vary the prices/fees for the adoption of different types of animals, an examination of fee structures for the largest shelters in the state suggests that this practice is far from uniform. Many charge a flat fee or vary prices based only on the age of the dog (i.e., premiums for puppies). And while shelters do run "specials," it appears to be reactive rather than proactive; that is, the episodic nature of the "sales" is likely to be in response to a glut of certain types of animals.

Survey

In the spring of 2013, the Michigan State of the State Survey (SOSS) conducted by the Institute for Public Policy and Social Research at Michigan State University, included questions on dog ownership and pricing. The SOSS is a quarterly survey of Michigan citizens and uses computer-assisted telephone interviewing to interview a stratified random sample of Michigan residents. (Both land and cell numbers are included in the sampling; more details on stratification and sampling procedures are available in Pierce [2013].) Different investigators design questionnaires for each round of surveys, although a core set of questions is included in all surveys and the sample includes new respondents as well as individuals who participated previously and agreed to be recontacted.

A total of 1,012 interviews were completed for a response rate of 35.8%. The dog questions, which serve as the data for the research here, focused on history of dog ownership and, for dog guardians, the nature of their current dog (most recently acquired in the case of multiple dogs), the purpose for acquisition, source of the dog, and price of the dog.

Sample characteristics

Table 1 provides basic demographic information for those responding to the survey along with a comparison to the state of Michigan as a whole. Respondents are relatively representative of the state on gender, race, region, and marital status, but they are significantly older, better educated, less likely to be in poverty, and more likely to be employed. These differences may have some effect on the prices paid for the current dog, although potential effects on owned-dog characteristics are unknown.

Hedonic modeling

In the hedonic framework, the market is assumed to be in equilibrium. That is, the dog acquisition experience offer function (of a shelter, breeder, or other supplier of dogs) is equal to a potential owner's bid function so that the marginal cost of the dog acquisition experience is equal to the marginal valuation of the dog owner. Differences among potential guardians in their desire for different dog attributes as well as differences across dog adoptions in both sets of factors result in a heterogeneous dog acquisition market. If the assumptions of the hedonic framework hold true for the dog market, the cost (or price) of acquiring a dog is a function of dog characteristics and other characteristics of the acquisition experience. With properly scaled fees that are informed by the preferences of potential owners, average time in the shelter and the number of removals from the market (euthanasia) can be reduced.

Table 1. Sample characteristics.

Trait	Sample	State
Female	53%	51%
College graduate or higher	46%	26%
High school graduate or higher	97%	89%
Hispanic	3%	5%
White	77%	80%
Black	13%	14%
Asian	4%	3%
Married	54%	47%
Unemployed	5%	8%
Median age	66	40
Incomes less than $20,000*	12%	17%
Region		
Upper Peninsula	3%	3%
Northern Lower Peninsula	5%	5%
West Central	15%	17%
East Central	9%	9%
Southwest	14%	12%
Southeast	47%	47%
Detroit	7%	7%
N	1,012	9,883,640

*The Michigan State of the State Survey (SOSS) asks income by category; thus, it is not possible to calculate a median income. Incomes less than $20,000 are generally considered to place residents in poverty; however, the SOSS does not correct for number of individuals in the household. More respondents may be in poverty than the percent with incomes less than $20,000 depending on household members; thus, respondents may be relatively representative of state poverty rates.

To examine the connection between dog acquisition costs and dog characteristics, it first is useful to consider whether dog characteristics are correlated with the characteristics of guardians; establishing that there is a relationship between potential guardian characteristics and dog characteristics is a first step in affirming the notion that owners with preferences for certain characteristics may in fact be willing to incur additional expenses to obtain a dog with such characteristics. It will also show the inverse: the identification of characteristics that must be discounted because they are not desirable to potential guardians. Thus, a series of regressions are estimated in which various dog characteristics are used as independent variables and are functions of guardian characteristics. With the exception of the age of the dog, all dog characteristic variables are binary (0–1) indicator variables. A significant portion of the observations for money spent on dogs is 0 (34%). Therefore, these regressions are estimated using a censored latent variable Tobit estimation procedure; average partial effects are reported in the Logit regressions. For a detailed discussion of the Tobit procedure, see Tobin (1958). The adoption cost regression analysis is based on the following equations:

$$y_i^* = \alpha + X_i(\beta) + \varepsilon_i \tag{1}$$

$$y_i = \begin{cases} y_i^* & \text{if} \quad y_i^* > 0 \\ 0 & \text{if} \quad y_i^* \leq 0 \end{cases} \tag{2}$$

where y_i^* is a latent variable that represents the cost (or price) of a dog i, X_i is a set of dog characteristics, β is the corresponding vector of parameters, α is the constant term to be estimated, and ε_i is the error term. Equation 2 implies that the observed variable y equals the latent variable y^* when y^* is greater than 0.

Table 2. Frequencies, purpose of current dog.

Trait	% indicating yes
Show dog	1
Working dog	4
Protection	25
Personal companion	91
For children	47
Companion to another dog	26
To save the dog from shelter	32
Friends have dogs	25

Note. $N = 439$; categories represent separate questions and are not mutually exclusive.

Results

Frequency data

At the outset, it is useful to discuss some basic descriptive information about dog ownership in Michigan based on the sample of respondents to provide a context for the regression models to follow. Four hundred thirty-nine respondents (44%) currently own at least one dog—an ownership rate that is at the higher end of national data indicating 37% to 47% of households own dogs (ASPCA, 2015b). Seventy-six percent of respondents had a dog at some point during their childhoods. (More than 400 cases are thus used for the analysis, which is an appropriate sample size to run robust regression analyses.) The childhood dogs were primarily indoor animals and were treated as companions or part of the family (78%); 18% were outdoors, and less than 1% were show dogs. The "purposes" of the dogs currently owned are shown in Table 2. Respondents acquired their dogs to be companions for themselves (91%), their children (47%), or their other dog/s (26%). Saving a dog from a shelter is also a common motivation (32%).

The majority of dogs were younger than 6 months old when acquired (72%), followed by 7 to 12 months (11%); 52% were male. Respondents in Michigan appear to prefer large (more than 50 lb [23 kg]; 40%) or small (11–30 lb [5–14 kg]; 30%) dogs. Fifteen percent of respondents had medium (31–50 lb) dogs and 15% had miniature dogs. Twenty-eight percent of the currently owned dogs were black. Mixed-breed dogs were most common (58%), followed by Labrador retrievers (14%), beagles (5%), and boxers and Yorkshire terriers (4%; other breeds were represented at less than 3%).

Respondents were asked a series of questions about traits of current dogs at the time they were acquired (Table 3). The most common traits of dogs at the point of acquisition were being child-safe

Table 3. Traits of current dog upon acquisition.

Trait	% indicating yes
Child-safe	92
Cat-safe	75
Dog-friendly	88
Health problems	8
Loss of limb	0
Blind	5
Deaf	8
Arthritis	0
Epilepsy	0
Hip dysplasia	7
Heart problems	0
Diabetes	0
Behavioral problems	2
Housebroken	34
Knows commands	37
Microchipped	10
Spay/neutered	28
Dewormed	74
Up-to-date on vaccinations	77

Note. $N = 439$; categories represent separate questions and are not mutually exclusive.

(92%), cat-safe (75%), and dog-friendly (88%). Having basic medical care in terms of vaccinations (77%) and deworming (74%) appeared to be important as did several behavioral traits such as being housebroken (34%) and knowing basic commands (37%). It did not appear that most dogs were acquired with health problems (8%).

The most common sources for the acquisition of the current dogs were from a family member or other individual (34%), breeders (30%), nonprofit rescues (10%), and licensed animal shelters (10%). Acquiring dogs from pet stores (5%) or breed-specific rescues (1%) or finding the dog as a stray (3%) were less common. The percentages of Michigan respondents getting their dogs from a shelter or rescue were lower than national estimates, which indicate 29% of cats and dogs coming from shelters and rescues (ASPCA, 2015b). The mean acquisition cost of currently owned dogs was $232.57; however, the median cost was $100. The most common cost of the current dog was free (31%). Nine percent of respondents paid $50, 8% paid $500, 7% paid $100, and 6% paid $300.

Correlations between owner and dog traits

As noted, the analysis began with examining the connection between dog and guardian characteristics. Significant correlations (χ^2 values were used due to the nominal nature of the data) are shown in Table 4. (Full results are available from the authors upon request.) Although due to space considerations, all significant correlations are not discussed in detail, human traits such as gender, education, race, and age appeared to be significantly correlated with a variety of dog traits. For example, women were significantly more likely to acquire dogs for protection, companionship, and the purpose

Table 4. Correlations between dog traits and caregiver traits.

	Male	Female	Education	Latino	White	Black	Asian	Low income[a]	High income[a]	Age
Social									7.26**	18.16**
Kids			20.97*		7.23**					50.86**
Working	10.53**									
Protection		7.21**				10.87**				21.33**
Show dog										20.17**
Companion to animal		3.85*				4.52*		3.73*		
Rescue		9.99**	27.29**		10.74	5.21*	4.35*			31.81**
Child-safe										14.98*
Cat-safe										34.06**
Age		13.85*			16.28*	12.75*				83.40**
Sex		5.25*	37.86**		19.02**		8.35*			
Color		29.17**	280.95**		16.31*	18.57*	15.57			91.35**
Source	14.93*	14.93*	132.23**		27.23*	24.62**		16.07*	19.46**	73.35**
Size			61.96**		18.01**					64.65**
Shed			61.70**				15.89**			53.24**
Hypoallergenic			23.66**		26.83**	15.54**				24.60**
Purebred			23.85**	4.49*			4.61*			24.4
Pit-bull			52.65**			3.89*		8.14		19.41**
breed				31.04**	45.82**		74.39**			
Deaf			21.32**					8.00**		
Housebroken			35.48**		5.90*		4.74*			
Commands			22.64*					6.15*	6.25*	
Dewormed			19.93*		8.71**		19.15**	7.72**		14.21*
Shots			18.74*			5.51*				15.66*
Dog friendly					13.42**					26.81**
Illness					4.31*	10.36**				25.30**
Blind										16.49*
Behavioral problems										16.49*
Spayed/neutered					5.91*					13.40*

Note. Values are × 2 due to the nominal nature of the data; only significant correlations are shown.
[a]Low income = less than $20,000. High income = more than $150,000.
*Correlation significant at the .05 level.
**Correlation significant at the .01 level.
$N = 439$.

of rescuing them. Thus, women were significantly more likely to obtain their dogs from shelters, nonprofit rescues, or friends/family. Respondents with college educations were more likely to adopt from a shelter or rescue and tended to acquire their dogs for their children. Respondents with a high school education were most likely to have pit-bull mixes and purebred dogs as compared with those who are more highly educated.

Latinos were more likely than other races to have purebred dogs—beagles and boxers in particular. White respondents were significantly more likely than other races to acquire a dog in order to rescue it and were more likely to have "other" breeds and Labrador retrievers. They were significantly more likely than Non-Whites to adopt dogs from shelters and nonprofit rescues. African Americans tended to own dogs for protection as opposed to rescuing a dog as compared with other races. They tended to have hypoallergenic dogs and pit-bull mixes; they were significantly more likely to get their dogs from breeders or a pet store. Lower-income respondents (less than $20,000) were significantly more likely than those in other income groups to have acquired a dog who already knew commands, was a pit-bull mix, and was not dewormed prior to acquisition. Those with incomes less than $20,000 were also significantly more likely than those in other income groups to have gotten the dog from a family member or another person. Respondents with very high incomes (more than $150,000) were less likely than those in other income groups to have gotten a dog to fit in with a social circle or to have acquired a dog knowing commands. They were significantly more likely than those in other income groups to have gotten their dog from a breeder.

Finally, age of the owner was significantly correlated with a number of dog traits. In short, there appeared to be relatively clear lifecycle effects with older respondents being less concerned about child safety, middle-aged respondents being most likely to acquire a dog for children tending to favor mixed-breed dogs, and younger respondents apparently preferring purebred dogs or pit-bull mixes.

These relationships indicate there are a number of correlations between the traits of dogs and the individuals who own them. Thus, exploring the prices associated with those dogs should be fruitful in establishing appropriate pricing strategies to ensure that shelters can clear the market for dogs with particular characteristics in an optimal manner (i.e., through adoption).

Regression results

Several pricing estimations are presented. The first is a probit estimation of the decision to have a dog, where the dependent variable is equal to 1 if the respondent owns a dog and is equal to 0 otherwise: Let D_i be a discrete random variable equal to 1 when respondent i indicates dog ownership and 0 otherwise. The choice to own a dog is assumed to depend on a set of respondent characteristics, Z_i, and a random component, u_i. More precisely, the value of D_i is such that:

$$D_i = \begin{cases} 1 & \text{if} \quad Z_i \propto +u_i > 1 \\ 1 & \text{if} \quad Z_i \propto +u_i < 1 \end{cases} \tag{3}$$

where α is a vector of coefficients. The random component, u_i, is assumed to have a mean of 0.

Clearly the decision to acquire a dog must take place before issues of price are assessed. Table 5 presents the probit estimation results for dog ownership. Respondents who own a dog were significantly more likely to be younger than 65 years of age, married, have children, live in rural areas, and have higher incomes. African American respondents were significantly less likely to have a dog as were those with education of at least a college degree. Those having had a dog while growing up were also significantly more likely to currently own a dog. The pseudo-R^2 for the probit estimation indicated that just more than 16% of the variation in dog ownership is explained by the variables included in the specification.

The next series of Tobit regression estimates focused on the determinants of price. In the first specification, just the characteristics of dogs were regressed on price of the current dog to explore the relative importance of specific dog traits. This specification is most closely aligned with the hedonic

Table 5. Probit regression, human traits, and dog ownership.

Trait	Coefficient (marginal effect)[a]	Standard error	*z*	Significance
Asian	−0.79	.61	−1.30	.19
Black	−0.51	.17	−2.97	.00
All others	−0.11	.23	−0.50	.62
Married	0.42	.10	4.38	.00
Children	0.44	.11	4.02	.00
Employed full time	0.10	.12	0.94	.35
Homemaker	0.09	.17	0.50	.62
Rural	0.26	.12	2.14	.03
Town/village	0.10	.11	0.90	.37
Urban	0.13	.18	0.71	.48
College/greater	−0.19	.10	−1.93	.05
Childhood dog	0.74	.12	6.39	.00
Less than 10k	−0.21	.25	−0.84	.40
High income	0.30	.11	2.71	.01
Older than 65 years old	−0.59	.11	−5.26	.00
Constant	−1.12	.16	−7.2	.00

Note. Pseudo $R^2 = .1626$.
[a]The coefficient estimates reflect the marginal effect of each variable on the likelihood of dog ownership.
$N = 439$.

framework. However, human traits may also play a role in determining price. Thus, price is also regressed on human traits. These separate regressions allow for the assessment of the relative explanatory power of each set of characteristics on dog price. A specification in which both dog and human traits are included in the same regression is then considered. In the interests of parsimony, a more limited set of possible dog traits was used based on frequency in the respondent dog population but also to represent traits identified in the literature as being important in dog adoption decisions: age of dog (up to 6 months, and 7 years and older), sex, breed (purebred, pit bull), size (medium and small), basic services (microchipping, deworming, neutering, and vaccinations), and color (black, brown, and white). Dog traits with small numbers of responses, such as particular illnesses, were not included in the regression analyses.

Table 6 provides the results of the dog trait model: Puppies and purebred dogs as well as those who are microchipped garnered significantly higher prices. Black dogs were obtained at lower prices (significant at .08) compared with dogs of more "exotic" colors such as brown or white. The analyses were also conducted using interactions between particular dog traits such as black/size, age/size, and pit bull/age, but none of these variables were significant determinants of price. Not all potential interactions could be included because of small *N*s for many of the combinations. The Tobit estimation

Table 6. Dog traits and pricing of dog, marginal effects.

Trait	Coefficient (marginal effect)[a]	Standard error	*t* statistic	Significance
0–6 months	146.23	37.39	3.91	.00
Older than 7 years	−155.82	86.43	−1.80	.07
Male	50.04	34.76	1.44	.15
Small	−6.42	25.09	−0.26	.79
Medium	115.01	98.25	1.17	.24
Black	−62.80	33.91	−1.85	.06
Brown	−16.52	34.63	−0.48	.63
White	−45.03	39.63	−1.14	.25
Purebred	82.19	39.25	2.09	.03
Pit bull	−94.49	79.25	−1.19	.23
Microchip	187.90	55.99	3.36	.00
Dewormed	12.85	34.32	0.37	.70
Neutered	−37.22	32.83	−1.13	.25
Shots	15.69	48.47	0.32	.74

Note. Pseudo $R^2 = .015$.
[a]The coefficient estimates reflect the marginal effect of each variable on the price paid for a dog.
$N = 439$.

Table 7. Human traits and pricing of dog, marginal effects.

Trait	Coefficient (marginal effects)[a]	Standard error	*t* statistic	Significance
Asian	−170.43	101.55	−1.68	.09
Black	−34.49	82.33	−0.42	.67
All others	75.14	64.33	1.17	.24
Married	−45.84	39.93	−1.15	.25
Children	14.16	35.91	0.39	.69
Employed full time	−4.47	23.47	−0.19	.84
Homemaker	−36.15	52.56	−0.69	.49
Rural	−3.70	23.10	−0.16	.87
Town/village	2.21	23.64	0.09	.92
Urban	216.59	235.75	0.92	.35
College/greater	−5.25	31.80	−0.17	.86
Childhood dog	21.01	28.58	0.74	.46
Less than 10k	−47.85	87.90	−0.54	.58
High income	99.11	52.46	1.89	.05
Older than 65 years old	−34.96	34.01	−1.03	.30
Pet store	124.35	70.95	1.75	.08
Breeder	151.48	43.76	3.46	.00
Shelter/rescue	8.22	37.04	0.22	.82
Breed rescue	−49.59	84.34	−0.59	.55
Family/person	−97.62	36.03	−2.71	.00
Stray	−490.82	119.47	−4.11	.00

Note. Pseudo $R^2 = .023$.
[a]The coefficient estimates reflect the marginal effect of each variable on the price paid for a dog.
$N = 439$.

does not provide an R^2 measure of goodness of fit, but we do report pseudo-R^2 which is .015. The interpretation of this measure, however, is not comparable to the traditional R^2, but it is useful for comparing goodness of fit between alternative Tobit specifications.

Next, characteristics of guardians were regressed on price of dog, as shown in Table 7. Respondents with higher incomes were significantly more likely to pay higher prices for the dogs. Owner choices regarding the source of the dog were also related to price: Dogs from breeders or pet stores commanded significantly higher prices, and those who were found as strays commanded significantly lower prices.

The final regression combined dog and human traits; because only income appeared to be a human characteristic that is significantly correlated to dog price, it was the only human trait included in the specification along with the dog traits (Table 8). Acquisition at a shelter was also left in the model because shelter pricing is the focus of the study. Here higher incomes, puppies, purebred dogs, and microchipped dogs were significant positive determinants of price. Dogs who were black or older than 7 years old were associated with lower prices. The pseudo-R^2 for the combined model is .019. These estimates suggest that though respondent income may play a role in determining price, dog characteristics are most important.

Analyses including all dogs have been presented based on the premise (drawn from a sampling of shelter pricing schedules) that shelters are not using dog characteristics to price their dogs. However, separate regressions were also run for dogs from shelters and all other dogs (available from the authors upon request); results were as expected and strengthened the case that shelters could improve dog placement by considering dog characteristics in setting prices.

Discussion and policy recommendations

Based on the findings just discussed, it appears that shelter and rescue pricing systems should vary based on several critical dog traits. Specifically, puppies and purebred dogs can be priced at a premium, while older, mixed-breed, and black dogs should be priced at a discount. Other traits such as potential medical conditions do not appear to garner a discount. Higher prices can also be charged for dogs who are microchipped prior to adoption. Overall, traits of the dog are more important than traits of the dog owners (other than income) in the prices paid for dogs in Michigan.

Table 8. Full pricing model with dog and human traits, marginal effects.

Trait	Coefficient (marginal effect)[a]	Standard error	*t* statistic	Significance
Younger than 6 months old	141.84	36.94	3.84	.00
Older than 7 years old	−168.63	82.54	−2.04	.04
Male	50.43	34.90	1.45	.14
Small	−5.39	25.33	−0.21	.83
Medium	93.16	87.82	1.06	.28
Black	−72.85	36.17	−2.01	.04
Brown	−19.45	34.64	−0.56	.57
White	−32.52	36.31	−0.90	.37
Purebred	105.04	49.16	2.14	.03
Pit bull	−71.84	80.44	−0.89	.37
Microchip	143.46	50.16	2.86	.00
Dewormed	16.37	32.29	0.51	.61
Neutered	−48.19	36.84	−1.31	.19
Shots	−6.57	54.65	−0.12	.90
Shelter/rescue	92.98	57.69	1.61	.10
Less than 10k	−85.76	77.137	−1.11	.26
High income	80.87	33.98	2.38	.01

Note. Pseudo $R^2 = .018$.
[a]The coefficient estimates reflect the marginal effect of each variable on the price paid for a dog.
$N = 439$.

In some respects, the findings from Michigan confirm various relationships indicated in previous literature. For example, dog ownership is more common among those with higher incomes and among those who had dogs as children. Younger people are also more likely to have dogs. Respondents of child-rearing years are more likely to acquire a dog for their children, prefer dogs who are dog- and child-safe, and are more likely to have mixed-breed dogs.

Findings on the "black dog syndrome" in previous research have been mixed, which was reflected in the analysis here. Many respondents own black dogs but paid less for them. Previous research has indicated that younger individuals are more likely to prefer dogs perceived as aggressive (Egan & MacKenzie, 2012), and the Michigan data also indicate that younger respondents are both more likely to own pit-bull mixes and to acquire a dog for protection. There are also significant correlations in Michigan between owning such types of dogs and lower education and incomes and being African American. Finally, in Michigan, respondents from rural areas as well as White respondents are significantly more likely to have a dog.

More specifically related to pricing issues, the finding that many respondents own dogs who are black but paid less for them suggests that shelters could improve dog placement by proactively discounting black dogs. Although no statewide data are available on the numbers of black dogs admitted to shelters in Michigan or on their length of stay, data from two shelters in the Pacific Northwest indicate that black dogs are more numerous in shelters than are dogs of other colors (Svoboda & Hoffman, 2015).

Although the majority of respondents have mixed-breed dogs, they also paid less for them, suggesting that shelters can put cost premiums on purebred dogs. Again, while shelters may periodically have price reductions on certain types of animals—such as black dogs—when they determine there are too many sitting in the shelter, proactively pricing such dogs at a discount may reduce days to adoption and euthanasia when the shelter becomes too full.

There were no significant correlations between health or behavioral problems and price, but the large majority of dogs were not acquired with any of these issues. This finding suggests that shelters do not need to discount dogs with medical concerns.

The absence of a relationship between price and acquisition at a shelter in multiple regression is also worth noting. It suggests that shelter dogs are not acquired at significantly lower prices, which on its face may discourage adoption from shelters. However, such dogs are often sterilized and provided with basic vaccinations and other medical care as part of the adoption price. Thus, adopters are getting a better value than from other potential sources such as breeders. Shelters would do well to better publicize these cost-efficiencies.

Based on the pricing regressions, it appears clear that shelters do need to vary their pricing systems to discount particular traits, specifically for mixed-breed, older, and black dogs. By the same token, they may be able to command higher prices if they microchip dogs. Given that higher-income individuals are both more likely to have dogs and to pay higher prices for them, shelters may want to consider placing a base price on each dog (with appropriate discounts as noted) and then encouraging purchasers to consider paying more than that base price as a donation (or legacy costs) to the shelter or as a subsidy for less desirable dogs. An important caveat is needed here, however. Pricing is not the only relevant aspect of the dog adoption process that shelters need to consider. Simply lowering prices on older dogs who may be about to enter a life stage with higher health costs may encourage individuals with insufficient means to adopt them. Pricing systems must be tied to appropriate adoption counseling procedures that consider a variety of aspects of the potential placement.

It is clear that traits of the dog are more strongly related to price than are guardian traits with the exception of income. Yet, none of the models do a particularly good job of explaining prices paid for dogs. The most likely omitted variables are those related to the more intangible or emotional values of dogs. Although such issues are partially accounted for by the questions related to the reasons behind the acquisition of the current dog, clearly, some aspects of the human–animal bond are missing from the analysis. Future research would do well to explore the motivations for dog ownership and prices paid in more detail and perhaps using more qualitative methods. For example, respondents pay more for a dog if they are acquiring the dog as a companion than for other reasons such as protection, show purposes, or to be a working dog (significant at the .07 level). This fact hints at the intangible and potentially emotional reasons for choosing and paying a given price for a particular dog that are not well measured in this survey.

Finally, acquiring a dog from a shelter is relatively uncommon in Michigan and indeed is much less common in Michigan than the literature suggests for the nation as a whole. Respondents with more education, women, older respondents, and Whites are most likely to acquire their dogs from a shelter or for the purpose of rescuing them. This conclusion is related to the finding that Latinos and Asians are significantly more likely to own purebred dogs. The results suggest animal shelters in the state may need to be especially concerned with promotion to increase awareness about the importance of adoption particularly targeted to specific groups.

Appealing to men and potential owners of color appears important in increasing the rates of adoption (i.e., "adopt don't shop" campaigns) while also emphasizing the often common availability of purebred dogs in shelters. Further, individuals in their child-rearing years are most likely to have mixed-breed dogs yet are less likely to have acquired them from shelters. Awareness campaigns targeted to families promoting the availability of child-friendly mixed-breed dogs at the local shelter also appear warranted. In short, proactive pricing systems that offer discounts for older and black dogs, premiums for puppies, purebred dogs, and those with enhancements such as microchips and more active informational campaigns should help to both raise revenue for shelters and increase the likelihood that no dog is left behind.

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