SHELTER ANIMAL OUTCOMES

Helping Improve Outcomes for Shelter Animals

Abstract

This study examines trends in shelter animal outcomes and identifies insights that could assist shelters in focusing their resources on those animals that need extra attention in finding a forever home. The study examines over 25,000 observations of shelter animal data and attempts to predict the outcomes of euthanasia and adoption using the animal's characteristics such as breed, age, sex, intactness, and coat color.

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Introduction

It is widely agreeable that the animal-human bond is a strong one, as proven by the nearly 78 million dogs and 86 million cats kept as companion animals in the U.S. today. Every year approximately 6.5 million companion animals end up in U.S. shelters, and as many as 1.5 million are euthanized every year. These figures have declined since 2011, likely from an increased reliance on technology leading to more strays being returned to their owners, and adoption awareness campaigns ("Pet Statistics", 2017). This study hopes to examine trends in shelter animal outcomes and identify insights that could help shelters focus their resources on those animals that need extra attention in finding a forever home. The paper will begin with an overview of previous shelter adoption research on shelter housing, current outcome trends using linear regression models, and an analysis of the “Black Dog Syndrome” hypothesis. Next, a brief summary of the original data and model used will be provided, to be followed by empirical results and interpretation of statistical outputs. Then, the paper will review any implications, weaknesses, and possible extensions of this study. A reference section including access to the original dataset and technical appendix concludes the paper for further review.

Literature Review

In preparation of the study, a brief analysis of previous research was conducted for background information on the current work being done to examine trends in shelter animal outcomes. Authors Gourkow and Fraser published a study in 2006 for the “Universities Federation for Animal Welfare”, in which they conduct a controlled study of adult shelter cats in 4 different types of shelter housing to determine if the shelter environment has any impact on the

likelihood of adoption. Their intention of the study is to focus on adult cats, as they are the most difficult to rehome and spend the longest periods of time in shelters. The controlled study found that most adopters cited behavioral characteristics of the animal (friendly, playful, happy) as reason for selecting cats, and that these traits were generally associated with lower stress scores. The results of the study suggest that improved housing conditions can improve the chances for adoption of adult shelter cats. This study has significant implications for cost-efficient policies that administrators could implement to easily improve outcomes for shelter animals.

In 2011, authors Morris, Wolf, and Geis from the Animal Assistance Foundation published *Trends in intake and outcome data for animal shelters in Colorado, 2000 to 2007* in the "Journal of the American Veterinary Medical Association". The objective of the study was to measure trends in outcome data for animals in Colorado shelters. This paper was found to be relevant in that the procedure of the study was to analyze the data using linear regression analysis with outcome data, similar to the procedure conducted in this current study. The report resulted in the statewide conclusion that intakes for dogs had significantly decreased, the intake for cats had increased, and that euthanasia rates for dogs was unchanged. The results also showed that there are clear distinctions of trends in the urban and rural data, suggesting different needs in each type of community. The conclusions also suggest that the dynamic for dog euthanasia appeared to reach equilibrium, giving shelters adequate expectations for improving the outcome of euthanasia. The study also suggests that the use of transfers (animals being transferred to other shelters based on shelter capabilities and community needs/expectations)

was increasingly being used within all regions of the state to optimize the chances of adoption. The study also confirms the industry expectation that age and intactness (whether the animal is spayed/neutered) are the most impactful variables in determining shelter animal outcomes.

The final study to be examined was conducted by Svoboda and Hoffman in 2015 and published in the journal, “Animal Welfare”. The objective of the study was to further analyze the popular press reporting that coat color bias negatively impacts shelter adoption rates for black domestic dogs. The study reports this phenomenon as ‘black dog syndrome’ (BDS) and that it increases the likelihood of euthanasia and may explain a higher than average amount of time in shelters. The study analyzed four years of intake and outcome data from only two shelters in the Pacific Northwest. The results concluded that the average length of time in shelter and rates of euthanasia for black dogs was not significantly larger than other colored dogs. The results did confirm the a priori assumption that age and breed group were more accurate predictors of shelter outcomes, and that aggressive breeds have a significantly longer time spent in shelters and rate of euthanasia than other breeds. The study only examines two shelters in a specific region of the U.S, showing a weakness of the study and opportunity for further research. The impacts of the study show that further analysis is necessary to determine the importance of BDS in determining outcome, and that if the variable proves to be insignificant, shelters may be misallocating their resources by dedicating more focus on promoting black dogs for adoption.

Data

The dataset used in the study was provided by the Austin Animal Shelter, with statistics taken from the ASPCA from October 2013 to March 2016, and includes over 25,000 observations of intake and outcome data for both dogs and cats. The original dataset includes the following variables: Outcome (Adoption, Euthanasia, Death, Return to Owner, and Transfer), Name of the animal (if available), Date and time of outcome, Outcome Subcategories, Breed, Coat Color, Sex, Age, and Intactness. The variable of date/time of outcome was omitted from the model, based on the data cleaning abilities needed to efficiently control for this variable. The information set in regard to outcome subcategories gives further explanations in regard to the animal's outcome. For example, the outcome of euthanasia includes subcategories such as suffering (age) and aggression. Subcategories for the outcome of death could include whether the animal died in foster care or transport. These subcategories were eliminated from the model but could be utilized in further studies. The original variable of Breed contained over 1600 specifications, and therefore was replaced with a proxy variable for Aggressive Breed to include the pure and mixed breeds of Pitt Bull, Staffordshire, Rottweiler, German Shepherd, Doberman, Chow, Great Dane, and Husky. This aggressive breed list was obtained from the U.S Department of Health. The original variable of Coat Color contained over 300 color descriptions, and therefore was replaced with a proxy variable to control for the aforementioned 'Black Dog Syndrome." The original Age variable was sorted into three discrete variables to include puppy/kitten (<1 yr), youth (1-5 years) and old (>5 years).

Model

The study includes two linear regression models focused on determining the specified outcomes of Adoption and Euthanasia, with the aforementioned explanatory variables and expected coefficient sign specified in tables 1 and 2 below. All variables in the model are in the form of discrete choice, taking on a value of either zero or one, with the coefficients being interpreted as an increase or decrease in the probability of the outcome.

Table 1:
Model 1-LPM Determinants of Adoption

Dependent Variable		
Outcome: ADOPTION	Probability of animal being adopted	
Independent Variables		
Age	3 discrete variables: • < 1 year = "Puppy/Kitten" • 1-5 years = "youth" • > 5 years = "old"	(-)
Sex	Discrete variable: Female=1	(+/-)
Fixed or Intact	Discrete Variable: Spayed or Neutered=1	(+)
Cat or Dog	Discrete Variable: Dog=1	(+)
Color	Discrete Variable: Black=1	(-)
Given Name	Discrete Variable: Had a given name at time of outcome=1	(+)
Aggressive Breed	Discrete Variable: below breeds=1 • Bitt Pull Terrier • Staffordshire Terrier • Bull Terriers • Rottweilers • German Shepherd • Doberman Pincher • Chow • Great Dane • Husky	(-)

Table 2:
Model 2-LPM Determinants of Euthanasia

Dependent Variable		
Outcome: EUTHANASIA	Probability of animal being euthanized	
Independent Variables		
Age	3 discrete variables: • < 1 year = "Puppy/Kitten" • 1-5 years = "youth" • > 5 years = "old"	(+)
Sex	Discrete variable: Female=1	(+/-)
Fixed or Intact	Discrete Variable: Spayed or Neutered=1	(+/-)
Cat or Dog	Discrete Variable: Dog=1	(-)
Color	Discrete Variable: Black=1	(+)
Given Name	Discrete Variable: Had a given name at time of outcome=1	(-)
Aggressive Breed	Discrete Variable: below breeds=1 • Bitt Pull Terrier • Staffordshire Terrier • Bull Terriers • Rottweilers • German Shepherd • Doberman Pincher • Chow • Great Dane • Husky	(+)

From tables 1 & 2, we can see that the expected coefficient signs for each of the two models are opposite, for example, we expect age to have a negative impact on adoption, but a positive impact on euthanasia. Determining the relationship between sex and both outcomes is uncertain. From previous research, we can assume that if the animal has been spayed or neutered, that it would positively impact adoption rates, but the impact on euthanasia is uncertain. Based on the previous literature and the statistical history of cats being adopted less and more often euthanized, we can predict that the discrete variable of Dog=1 will have a positive relationship with adoption and a negative relationship with euthanasia. To test the theory based on the Svoboda and Hoffman study mentioned above, we will predict that if an animal has a black coat, this will have a negative relationship with adoption probability and a positive relationship with euthanasia probability. We are also curious to know if giving the animal a name prior to the outcome has a significant impact on the animal's outcome. If the animal has been given a name prior to the outcome we predict that it will have a higher probability of adoption, and a reduced probability of euthanasia. Finally, we will identify if the animal has been classified as belonging to one of the nine aggressive breeds (mixed or pure) established by the USDH, and examine that effect on probability of outcome. Consistent with previous research and a priori assumptions, we can predict that aggressive breeds will have a decreased probability of adoption and an increased probability of euthanasia when compared to a non-aggressive breed.

Descriptive Statistics

Table 3 below presents the descriptive statistics for all model variables to include mean, standard deviation, minimum, maximum, and number of observations. Due to the fact that all variables are discrete choice, or dummy variables, the minimum and maximum values for all variables are 0 and 1, respectively, with 25,619 observations for each variable.

Table 3: Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max	Observations
ADOPTED	0.4204	0.4936	0	1	25,619
EUTHANIZED	0.0567	0.2312	0	1	25,619
TRANSFER	0.3300	0.4702	0	1	25,619
RETURN	0.1862	0.3893	0	1	25,619
DIED	0.0067	0.0817	0	1	25,619
DOG	0.6056	0.4887	0	1	25,619
FIXED	0.7259	0.4461	0	1	25,619
FEMALE	0.4810	0.4996	0	1	25,619
BABY	0.4316	0.4953	0	1	25,619
YOUTH	0.4431	0.4968	0	1	25,619
OLD	0.1253	0.3310	0	1	25,619
AGGRESSIVE	0.1633	0.3697	0	1	25,619
NAME	.741559	.4377862	0	1	25,619
BLACK	0.2987	0.4577	0	1	25,619

Based on the statistics in Table 3, we can note that only 42% of shelter animals have an outcome of adoption, around 6% are euthanized, 33% are transferred, about 19% are reunited with their owners, and less than 1% die in shelter care. The data set includes both dogs and cats, with 60% of the observations being dogs, and the remaining 40% are cats. About 73% of

the animals observed are spayed or neutered, and 48% of the data set are female. With regard to age, both puppies/kittens (less than 1 year) and youth (1-5 years) hold roughly the same proportion of the observations (43% and 44%, respectively) and the remaining 13% being more than 5 years old. Breeds classified as “aggressive” comprise about 16% of the dataset, and 30% of the animals have black in their coat description.

Empirical Results

Tables 4 and 5 below show the coefficients of the LPM regression for both models, with the variables listed in order of magnitude. Asterisks (*, **, & ***) indicate significance at 0.1, 0.5, and 0.01, respectively, using the P-value approach, with P-values in parenthesis.

Table 4:	LPM Adoption
FIXED	.55204*** (0.000)
OLD	-.39351*** (0.000)
YOUTH	-.25591*** (0.000)
NAME	.07522*** (0.000)
PIT	-.04977*** (0.000)
FEMALE	.03996*** (0.000)
AGGRESSIVE	-.03402*** (0.001)
DOG	-.01184 (0.053)
BLACK	-.00687 (0.229)
CONS	.12675*** (0.000)
Adjusted R^2	0.3031
F_{calc}	1238.93*** (0.000)

Table 5:	LPM Euthanasia
OLD	.13715*** (0.000)
FIXED	-.08455*** (0.000)
YOUTH	.06506*** (0.000)
PIT	.06390*** (0.000)
NAME	-.05851*** (0.000)
AGGRESSIVE	.02812*** (0.000)
DOG	-.02440*** (0.000)
FEMALE	-.01214*** (0.000)
BLACK	.00500 (0.103)
CONS	.12398*** (0.000)
Adjusted R^2	0.0838
F_{calc}	261.24*** (0.000)

For both models, all coefficient signs are consistent with a priori assumptions mentioned previously, with the exception of the DOG variable under the adoption model, but it proves to be statistically insignificant. All variables proven to be significant are so at the 99% confidence level. Under both models for explaining adoption or euthanasia outcomes, the most impactful variables are FIXED and AGE, which are consistent with a priori predictions. Also, consistent with previous predictions, older dogs are less likely to be adopted and more likely to be euthanized than puppies/kittens, and female animals are more likely to be adopted than male

animals. Aggressive breeds in general are about 3.5% less likely to be adopted and about 2.8% more likely to be euthanized than other breeds, with Pit Bulls specifically about 5% less likely to be adopted and 6.4% more likely to be euthanized in comparison to other breeds. Consistent with the findings of the Svoboda and Hoffman study, "Black Dog Symptom" is not a statistically significant variable in explaining either outcome of adoption or euthanasia in this study. The data shows that giving the animal a name prior to their outcome is statistically significant in explaining both outcomes, with an increase of 7.5% in adoption rate and a 5.8% decrease in euthanasia likelihood. Both models have a relatively low R^2, which is to be expected due to several excluded variables which could be incorporated in further studies, however both models do have overall significance under the F-test approach.

Weaknesses and Extensions

Due to the nature of the original dataset, there are several weaknesses and extensions to be identified in this study. There is an inherent difficulty in breed identification with many mixed breeds in the data set and over 1600 specifications. In further extensions, it would be beneficial to categorize the breeds into different classifications such as hunting or toy groups, or classify the animals by weight class. It could be predicted that the R^2 would be significantly improved if the variables of time/date of outcome, and time spent in the shelter could be included in the model. Further analysis of a more nationally aggregated dataset may also give further insights into the significance of the "Black Dog Syndrome." Further extensions of this study could include an analysis of the psychological ramifications of euthanasia-related work. In future studies, it would also be useful to run a separate analysis for dogs than cats, as some of the

variables may fall risk to multicollinearity. In further studies, it may also be beneficial to control for rural versus urban areas to further explore the conclusions drawn in the Morris, Wolf, and Geis study. Broader extensions would also be improved by including information on the shelter housing conditions to further explore the hypotheses previously stated by the Gourkow and Fraser study. The original dataset also included sub-classifications for the different outcomes of shelter animals, and could be used to further evaluate the effectiveness of transfers, foster care, and prove useful in evaluating aggressive breed behavior and subsequent outcomes.

Conclusions and Implications

As expected, the most significant explanatory variables in explaining both adoption and euthanasia outcomes are age and intactness. Pit bulls and aggressive breeds are clearly facing discrimination as shown by the high rates of euthanasia and low rates of adoption. In the opinion of the author, the most impactful implication of this study is the significance of naming the shelter animal before their outcome. This would be a simple option to improve the outcomes for shelter animals at no cost to the shelters, and would do well to be implemented in company policies. It is widely accepted that aggressive breeds, and especially Pit Bulls, get a bad reputation in regard to adoption preferences. This is another important observation when considering allocating shelter resources, as these breeds may do well in auxiliary adoption promotion environments such as prison rehabilitation programs, or anxiety aid in hospitals, airports, and assisted living homes. Although much more work remains to be done to further improve outcomes for shelter animals, this study at least proves that Bob Barker has always been accurate in his signature directive, “Remember to spay and neuter your pets!”

References

www.kaggle.com --Shelter Animal Outcomes Competition Forum

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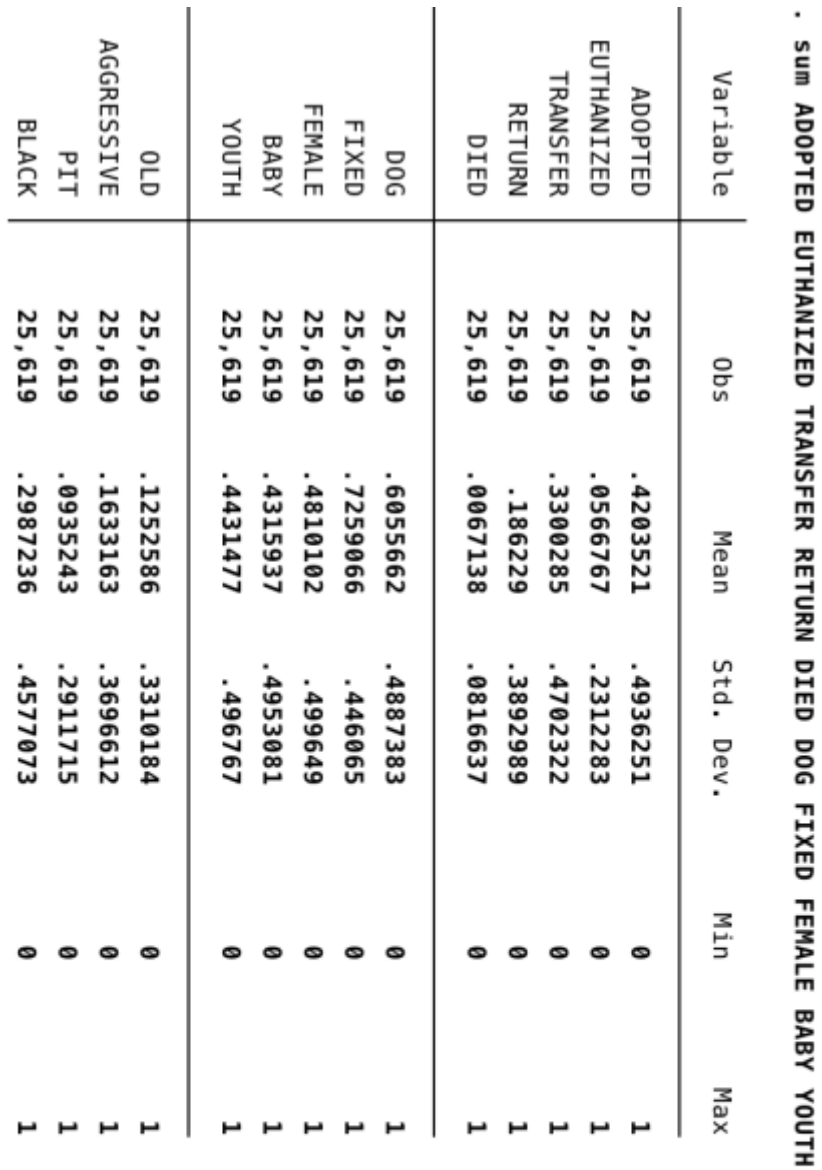
Trends in intake and outcome data for animal shelters in Colorado, 2000-2007. K. Morris, J.Wolf, D.Gies. 2011. Journal of the American Veterinary Medical Association. http://avmajournals.avma.org/doi/abs/10.2460/javma.238.3.329

Technical Appendix



```
. sum ADOPTED EUTHANIZED TRANSFER RETURN DIED DOG FIXED FEMALE BABY YOUTH OLD AGGRESSIVE PIT BLACK

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     ADOPTED |    25,619    .4203521    .4936251         0          1
  EUTHANIZED |    25,619   .0566767    .2312283         0          1
    TRANSFER |    25,619   .3300285    .4702322         0          1
      RETURN |    25,619    .186229    .3892989         0          1
        DIED |    25,619   .0067138    .0816637         0          1
-------------+--------------------------------------------------------
         DOG |    25,619   .6055662    .4887383         0          1
       FIXED |    25,619   .7259066     .446065         0          1
      FEMALE |    25,619   .4810102     .499649         0          1
        BABY |    25,619   .4315937    .4953081         0          1
       YOUTH |    25,619   .4431477     .496767         0          1
         OLD |    25,619   .1252586    .3310184         0          1
AGGRESSIVE |    25,619   .1633163    .3696612         0          1
         PIT |    25,619   .0935243    .2911715         0          1
       BLACK |    25,619   .2987236    .4577073         0          1
```

```
. reg ADOPTED DOG FIXED FEMALE BABY YOUTH OLD AGGRESSIVE PIT BLACK
note: BABY omitted because of collinearity
```

Source	SS	df	MS		
Model	1872.43728	8	234.05466	Number of obs	= 25,619
Residual	4369.79114	25,610	.170628315	F(8, 25610)	= 1371.72
				Prob > F	= 0.0000
Total	6242.22842	25,618	.24366572	R-squared	= 0.3000
				Adj R-squared	= 0.2997
				Root MSE	= .41307

ADOPTED	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DOG	-.0050908	.0061045	-0.83	0.404	-.017056	.0068744
FIXED	.5808859	.0060196	96.50	0.000	.5690871	.5926848
FEMALE	.03982	.0051724	7.70	0.000	.0296819	.0499582
BABY	0	(omitted)				
YOUTH	-.2485444	.0059425	-41.82	0.000	-.260192	-.2368968
OLD	-.3811999	.0085816	-44.42	0.000	-.3980204	-.3643794
AGGRESSIVE	-.0308509	.0105895	-2.91	0.004	-.0516068	-.0100949
PIT	-.0458884	.0130704	-3.51	0.000	-.0715071	-.0202698
BLACK	-.0062588	.0057275	-1.09	0.275	-.0174851	.0049674
_cons	.1517023	.0064151	23.65	0.000	.1391284	.1642763

```
. cor ADOPTED EUTHANIZED TRANSFER RETURN DIED DOG FIXED FEMALE BABY YOUTH OLD AGGRESSIVE PIT BLACK
(obs=25,619)
```

	ADOPTED	EUTHAN~D	TRANSFER	RETURN	DIED	DOG	FIXED	FEMALE	BABY	YOUTH	OLD	AGGRES~E	PIT	BLACK
ADOPTED	1.0000													
EUTHANIZED	-0.2087	1.0000												
TRANSFER	-0.5977	-0.1720	1.0000											
RETURN	-0.4074	-0.1173	-0.3358	1.0000										
DIED	-0.0700	-0.0202	-0.0577	-0.0393	1.0000									
DOG	-0.0039	-0.0160	-0.2144	0.2849	-0.0549	1.0000								
FIXED	0.4593	-0.1809	-0.4756	0.1193	-0.0941	0.2255	1.0000							
FEMALE	0.0331	-0.0221	0.0185	-0.0493	-0.0084	-0.0411	-0.0221	1.0000						
BABY	0.1744	-0.1079	0.1225	-0.3140	0.0432	-0.3595	-0.2160	0.0130	1.0000					
YOUTH	-0.0936	0.0338	-0.0558	0.1739	-0.0377	0.2823	0.1508	-0.0113	-0.7773	1.0000				
OLD	-0.1204	0.1107	-0.0996	0.2088	-0.0080	0.1143	0.0969	-0.0025	-0.3297	-0.3376	1.0000			
AGGRESSIVE	-0.0626	0.0863	-0.0965	0.1491	-0.0208	0.3566	0.0364	-0.0181	-0.1449	0.1447	-0.0003	1.0000		
PIT	-0.0709	0.1022	-0.0612	0.1060	-0.0133	0.2592	0.0053	-0.0042	-0.1234	0.1385	-0.0231	0.7270	1.0000	
BLACK	0.0064	-0.0032	-0.0183	0.0157	0.0006	0.0872	0.0248	-0.0318	0.0033	-0.0050	0.0027	0.0547	-0.0591	1.0000