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Cautionary Note on Computing Site-Specific Recreational Demand Elasticities and Welfare Estimates

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Abstract

This cautionary note achieves three important integrative goals. First is justifying the need for applied agricultural and resource economists to increasingly use flexible modeling techniques, such as the Box-Cox power family of transformations model, for reducing specification bias in recreational demand estimation. Second is demonstrating that findings from fitting inflexible functional form models tend to generate incorrect public policies on consumer welfare estimates. Third is establishing the importance of evaluating the demand elasticity estimates not only at the mean data values but also at the different data points, including at extreme data values, in the observed data space.

Keywords: Box-Cox, elasticity, functional form, recreational demand

1. Introduction

Changing energy prices have resulted in changes in recreational travel demand and associated costs. These changes have had noticeable economic impacts on recreational demand sites. The determinants of recreational demand generally include household income, social status, household head gender, demographic composition, travel costs including fixed annual access fees (English, 2010), recreational substitutes and complements, site-specific characteristics (Paudel, Caffey, & Devkota, 2011; Yen & Adamowicz, 1994) and other factors. Recreational demand elasticities and welfare estimates are capable of yielding relevant policy insights. It is crucial for economists to use appropriate econometric tools for modeling and estimation from which the elasticities and welfare effects are derived. Consequently, the estimates researchers obtain from the fitting of erroneous functional forms to data would likely yield incorrect inferences and suboptimal pricing strategies and public policies (Kling, 1989; Mallela, 1980). Recreational demand studies in the past 25 years mostly used various functional forms that are *a priori* inflexible, e.g., linear or log-log (see, for example, Egan, Herriges, Kling, & Downing, 2009). Despite advances in functional form modeling, such as the skew-correcting Box-Cox transformation (e.g., Ozuna Jr., Jones, & Capps Jr., 1993), the second-order Diewert flexible translog form (Creel, 1997) and nested Constant Elasticity of Substitution (CES) form (Morey, Breffle, & Greene, 2001) only a very limited number of researchers (e.g., Sutherland, 1982) used the more flexible and parametrically richer family of transformations models.

Using the 2011 annual *Journal Citation Reports*[1] database **[footnote 1]** we extensively reviewed recreational demand articles and found two major shortcomings in the literature. First is the failure

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[1] Peer-review journals in ‘Recreation and leisure Studies’, listing the leading journals in the area of recreation and leisure, is an alternative method for literature review. http://wilderdom.com/journals/journalsRecreation&Leisure.htm

to use the more flexible model estimation techniques in most cases. Second is the absence of computed elasticities and welfare estimate and the limiting of relevant policy inferences to elasticities evaluated at the data means whereas computations at other data points are useful and informative in their own right.

2. Failure to Use More Flexible Estimating Functional Form Models

Despite the well-known major benefits of estimating the more flexible functional form models (Okunade, 1992), agricultural and resources economists lag behind (e.g., Bilgic, Florkowski, Yoder, & Schreiner, 2008; Phaneuf, Kling, & Herriges, 2000; Pyo, Uysal, & McLellan, 1991) in applying them to modeling recreational demands. Surprisingly in almost 20 years, the Ozuna Jr. *et al.* (1993) study is uniquely the only one to have specified and estimated an *a priori* flexible recreational demand model. They modeled the number of trips to 3 distinct estuaries (Trinity-San Jacinto, Guadalupe-Mission-Aransas, and Nueces) using the Box-Cox transformation form and data on Texas households who had traveled to one of these estuaries between January and August 1986. Results based on the semi-log and double-log specifications were also given. They computed the welfare estimates only at the data means across the estuaries; however, no policy relevant elasticity estimates were reported. Here, we advanced the Ozuna Jr. *et al.,* (1993) work by first deriving and presenting in Table 1 the analytic expressions for computing the elasticities and welfare estimates for each estimated functional form model (restricted log-log and semi-log, and the unrestricted *a priori* flexible Box-Cox) at the data means and extreme data values (e.g., minimum, maximum).

Table 1. Recreational demand elasticity and consumer surplus expressions across models

	Elasticity Expression	**Consumer surplus Expression**
Double log	β	$\left[\frac{1}{\beta} e^{Z\delta} X^{\beta+1}\right]_{X_1}^{e^{\beta+Z\delta}}$
Semi-log	$\frac{\beta}{Y}$	$\beta[\, X lnX - X]_{X_1}^{e^{-\frac{Z\delta}{\beta}}} + Z\delta[X]_{X_1}^{e^{-\frac{Z\delta}{\beta}}}$
Box-Cox	$\frac{\beta}{\gamma} X^{\gamma}\left[\frac{\beta\lambda}{\gamma}\ (X^{\gamma}-1)\ +\lambda Z\delta\right]^{-1}$	$\left[X(\frac{\beta\lambda}{\gamma}X^{\gamma}+c)^{\frac{1}{\lambda}}(\frac{\beta X^{\gamma}}{\gamma Z\delta-\beta}+1)^{-\frac{1}{\lambda}} H\,(\frac{1}{\gamma}, -\frac{1}{\lambda}, 1+\frac{1}{\gamma}, -\frac{\beta X^{\gamma}}{\gamma Z\delta-\beta})\right]_{X_1}^{\left(1-\frac{\lambda\gamma Z}{\beta}\right)^{\frac{1}{\lambda}}}$

The basic model in Ozuna Jr. *et al.* (1993) is:

$$Y^{(\lambda)} = X^{(\gamma)}\beta + Z\delta + \varepsilon \tag{1}$$

where the $\varepsilon's$ are independent and identically distributed $N(O,\sigma^2)$ disturbance terms; β and δ are $(K \times 1)$ and $(J \times 1\,)$ column vectors of unknown parameters; and $X\ and\ Z$ are $(T \times K)$ and $(T \times\ J)$ matrices of explanatory variables (Z is a matrix of zero-one dummy variables not subject to power transformations). As suggested by Box and Cox, Y and X undergo the following power transformations:

$$Y^{(\lambda)} = \begin{cases} \dfrac{Y^{\lambda}-1}{\lambda} & if\ \lambda \neq 0 \\ lnY & if\ \lambda = 0 \end{cases} \tag{2}$$

$$X^{(\gamma)} = \begin{cases} \frac{X^{\gamma}-1}{\gamma} & if\ \gamma \neq 0 \\ lnX & if\ \gamma = 0 \end{cases} \tag{3}$$

where λ and γ are unknown parameters. The transformations in (2) and (3) hold only for $Y > 0$ and $X > 0$ with the functional form dictated by parameters λ and γ that are jointly estimated with β, δ, and σ^2 by maximizing a nonlinear likelihood function.

As expected, the expressions for the elasticities and welfare estimates in Table 1 differ across model specifications. The more flexible Box-Cox transformation model yields elasticity estimates that vary with income and site-specific characteristics (Table 2). This is an advantageous attribute.

3. Limited Presentations on Elasticities and/or Welfare Estimates

Demand elasticities and welfare estimates are important in recreational demand studies, and not computing them would limit usefulness of research findings for making relevant policy (e.g., pricing the amenities at recreational sites) suggestions. Using the 2011 *Journal Citation Reports* (JCR) and the Wiley online library we found 31 articles on recreational demand published in the leading social sciences journals in the 1993 – 2008 period. Of these only 9 reported welfare values and 3 presented elasticities. In all cases, even when elasticity and welfare estimates were presented, researchers evaluated them only at the data means. This common practice easily lends itself to faulty policy prescriptions for failure to reveal elasticity values at data points other than at the mean. Using the Ozuna Jr. *et al.* (1993) study, we here illustrate the importance of variations in the elasticity estimates over the data space across the estuaries for each model. The results are in Table2.

Table 2, as expected, shows that the travel cost, income and substitute recreational site elasticities for each estuary are invariant to the number of trips in the log-log (constant elasticity) model. However, the elasticity values vary significantly across estuaries. All the elasticities have the *a priori* theoretically expected signs. The positive elasticities for the alternative recreational sites confirmed them to be pair-wise substitutes based on the amenities set offered.

When estuaries are considered individually, at the maximum data values, the travel cost and substitute site were found to be inelastic in demand with the Box-Cox transformation model and elastic with the log-log specification. Consequently, the implied pricing policies would differ depending on the fitted functional form model. More specifically at the maximum data values for the log-log model, prices should be reduced in order to raise the number of trips to a given estuary. Surprisingly, the preferred Box-Cox transformation model (which is superior relative to the semi-log or the log-log forms) suggests a price increase strategy to maximize recreational revenues. These conflicting pricing policy suggestions of the different functional form models imply that the fitting of an erroneous model to the observed data can mislead policy interventions. Moreover, the income elasticities vary significantly across estuaries, as is expected, when the Box-Cox model is used. For example, at Trinity San-Jacinto and the Nueces estuaries, the elasticities are numerically less than one (i.e., fishing activity as an economic good is a necessity) while at the Guadalupe Mission in Arkansas it is greater than one (fishing there is considered to be a luxury economic activity). These findings may reflect differences among recreationists at the various sites, which can be assumed to result in differences in behaviors and ultimately in different pricing policies. All else given, the current increase in travel cost may result in reduction of the budget available for recreation. For instance, at the Guadalupe Mission Aransas estuary the resulting decrease in the number of trips taken will be significantly higher than that observed at the other two estuaries.

The results arrayed in Table 2 further attest to the need to disaggregate the number of trips taken to all of the estuaries, as the demand at each site may reflect the characteristics of its own anglers and the resulting pricing policy implications at each site may differ from what aggregated data across estuaries may suggest. Moreover, constancy of the elasticities in the double-log functional form model contradicts empirical reality. The results in Table 2 illustrate the importance of specifying and fitting an *a priori* unrestrictive functional form model to the observed data.

Table 2. Elasticity estimates for the three estuary recreation demand models

Estuary	Regressor variables		Elasticities		
			Box-Cox[a]	Double-log	Semi-log
Trinity San-Jacinto n=481	Travel cost	Mean	-0.401	-0.446	-0.32
		Minimum	*	-0.446	-0.037
		Maximum	-0.681	-0.446	-2.962
	Income	Mean	0.047	0.033	0.023
		Minimum	*	0.033	3
		Maximum	0.036	0.033	0.060
	Substitute site	Mean	0.02	0.024	0.074
		Minimum	*	0.024	0
		Maximum	0.061	0.024	1.278
Guadalupe Mission-Aransas n=270	Travel cost	Mean	-0.631	-0.541	-0.322
		Minimum	*	-0.541	-0.036
		Maximum	-0.776	-0.541	-2.795
	Income	Mean	1.656	0.454	0.367
		Minimum	*	0.454	0.05
		Maximum	1.058	0.454	1
	Substitute site	Mean	0.071	0.021	1.154
		Minimum	*	0.021	0
		Maximum	0.038	0.021	1.074
Nueces n=327	Travel cost	Mean	-0.416	-0.397	-0.365
		Minimum	*	-0.397	-0.041
		Maximum	0.699	-0.397	-2.777
	Income	Mean	0.455	0.228	0.175
		Minimum	*	0.228	0.025
		Maximum	0.385	0.228	0.5
	Substitute site	Mean	0.012	0.013	0.055
		Minimum	*	0.013	0
		Maximum	0.051	0.013	1.526

Notes: * The denominator in the elasticity expression involves a division by a zero; so, the elasticity is not computable.

[a] Power transformations of the respective functional forms are: $\lambda = -0.05, \gamma = 0.31$ (Full Box-Cox); $\lambda = \gamma = 0$ (Double-log); and $\lambda = 1, \gamma = 0$ (Semi-log)

4. Conclusion

This research note has two major conclusions. The first is relative to the significant variability of recreational demand estimation results depending on model specification. Depending on the model specification, pricing and public policies can differ. Therefore, agricultural and resource economists can gain efficiency by fitting the more flexible Box-Cox functional forms to the data. Second, researchers should strive to use less aggregated data, and consider various points in the data space (e.g., at mean, minimum, maximum) when computing elasticities and welfare effects for policy making. Failure to consider the spatial and other disparities at recreational site amenities lead to faulty policy inferences.

References

[1] Bilgic, A., Florkowski, W. J., Yoder, J., & Schreiner, D. F. (2008). Estimating fishing and hunting leisure spending in the United States. *Tourism Management, 29*(4), 771-782.

[2] Creel, M. D. (1997). Welfare estimation using the fourier form: Simulation evidence for the recreation demand case. *The Review of Economics and Statistics, 79*(1), 88-94.

[3] Egan, K. J., Herriges, J. A., Kling, C. L., & Downing, J. A. **(**2009**)**. Valuing water quality as a function of water quality measures. *American Journal of Agricultural Economics*, *91*(1), 106-123. doi: 10.1111/j.1467-8276.2008.01182.x

[4] English, E. **(**2010**)**. Annual fees and recreation choice. *American Journal of Agricultural Economics*, *92*(4), 1103-1113. doi: 10.1093/ajae/aaq035

[5] Kling, C. L. (1989). The importance of the functional form in the estimation of welfare. *Western Journal of Agricultural Economics, 14*(1), 168-174.

[6] Mallela, P. (1980). Discrimination between linear and logarithmic forms- A note. *The Review of Economics and Statistics, 62*(1), 142-144.

[7] Morey, E. R., Breffle, W. S., & Greene, P. A. (2001). Two nested constant-elasticity-of-substitution models of recreational participation and site choice: An ‘alternatives’ model and an ‘expenditures’ model. *American Journal of Agricultural Economics, 83*(2), 414-427.

[8] Okunade, A. A. (1992). Functional forms and habit effects in the US demand for coffee. *Applied Economics, 24*(11), 1203-1212. doi: 10.1080/00036849200000130

[9] Ozuna Jr., T., Jones, L. L, & Capps Jr., O. (1993). Functional Form and Welfare Measures in Truncated Recreation Demand Models. *American Journal of Agricultural Economics 75*(4), 1030-1035. doi: 10.2307/1243990

[10] Paudel, K. P., Caffey, R. H, & Devkota, N. (2011). An evaluation of factors affecting the choice of coastal recreational activities. *Journal of Agricultural and Applied Economics 43*(2), 167–179.

[11] Phaneuf, D. J., Kling, C. L, & Herriges, J. A. (2000). Estimation and welfare calculations in a generalized corner solution model with an application to recreation demand. *The Review of Economics and Statistics*, *82*(1), 83-92.

[12] Pyo, S. S., Uysal, M., & McLellan, R. W. (1991). A linear expenditure model for tourism demand. *Annals of Tourism Research, 18*(3), 443-454. doi:10.1016/0160-7383(91)90051-C

[13] Sutherland, R. J. (1982). The sensitivity of travel cost estimates of the recreation demand to the functional form and definition of origin zones. *Western Journal of Agricultural Economics*, *7*(1), 87-98.

[14] Yen, S. T., & Adamowicz, W. L. (1994). Participation, trip frequency and site choice: A multinomial-poisson hurdle model of recreation demand. *Canadian Journal of Agricultural Economics, 42*(1), 65-76. doi: 10.1111/j.1744-7976.1994.tb00006.x

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