Application of Poisson Model in Non-Market Valuation, Cave Rock Climbing Data Analysis using SAS macros

Yuanfang Lin, Department of Applied Economics & Statistics, University of Nevada, Reno

Abstract: *The paper focuses on the application of the poisson model in the research of recreational economics using contingent valuation methods. User-friendly SAS macros developed by Dr. Fernandez are used to perform exploratory and Poisson models. The comparison is also made between SAS and some other statistical software, such as GAUSS and Limdep. The SAS Macros (Univar & Genmod) are very powerful tools for data exploration of contingent valuation survey especially in outlier detection, distribution analysis and graphic presentation.*

Keywords: Non-market goods, CVM, Travel cost, Univar-Macro, Genmod-Macro, Outlier detection.

Introduction

Natural resources, such as forests and environmental attributes are valuable assets in that they yield flows of services to people. They are named after non-market goods because it is the failure of the market system to allocate and price resources and environmental services correctly.

The contingent valuation method (CVM) uses survey questions to elicit people's preference for public goods by finding out what they would be willing to pay(WTP) for specified improvements in them. It is applied in our Cave rock climbing resource survey.

Cave rock is located along the southeast shore of Lake Tahoe in Douglas County, Nevada. It is a popular recreation area with rock climbers. Our study focuses on the preferences of rock climbers and uses a single-site travel cost method to determine the access to cave rock.

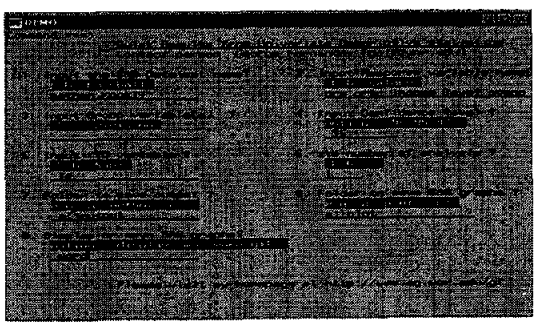
The Poisson model is selected as the statistically functional form to analyze the demand data in this study. (Later application of Univar macro will explain why we don't choose normal distribution as the right data generating process.) The demand curve is a reflection of travel cost to Cave rock (Crtc), annual income , climbing level , times of gym climbing (Gymno) and one dummy variable: gender . The basic demand relationship is given as follows:

Trips to Cave rock (Crs)= f (Crtc + Income +Climg level+ Gymno +Gender)

The area under the demand curve is the consumer surplus, i.e. people's willingness to pay (WTP) for preventing the loss of this climbing site.

Data Analysis and Comparison

The total survey response gave us 137 observations. Environmental researchers always try best to conduct a valid CV survey consisting of a believable and meaningful set of questions which will simulate a market for the public good in question. Unfortunately, no matter how they wish the respondents' answers may be taken as an accurate representation of how they would behave if confronted with an actual market , there will still be some off-the-cuff or careless responses which do not reflect real preference but will definitely make the estimation biased. So it is very necessary for the work of cleaning raw data. Some too high or low responses will probably be regarded as outliers and be cleaned based on researchers' common sense. In our case, the SAS Univar macro provides a powerful and user-friendly tool for exploratory analysis in CVM research.

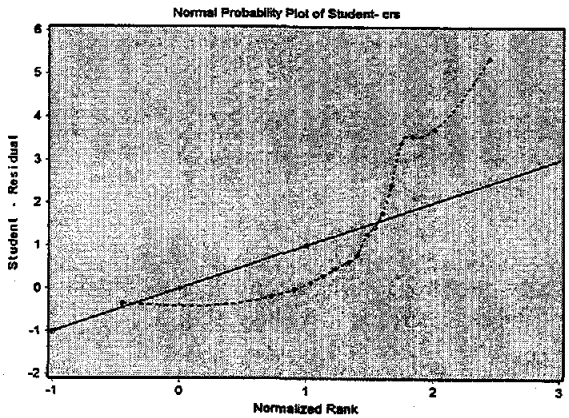


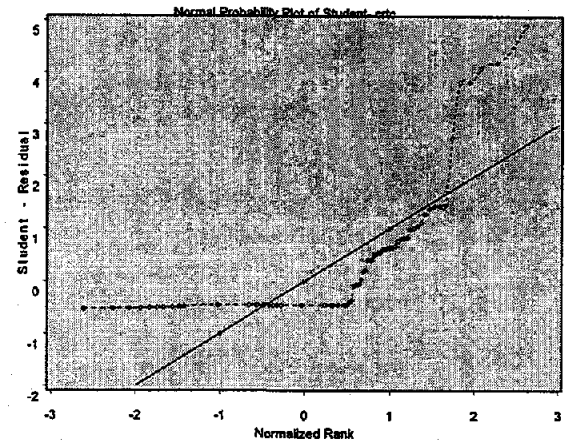
The result of Univar macro output the general data descriptions, such as Different mid values, Measures of central tendencies, Five number summary, Five number summary for trimmed (5%)data, Measures of variability, Measures of

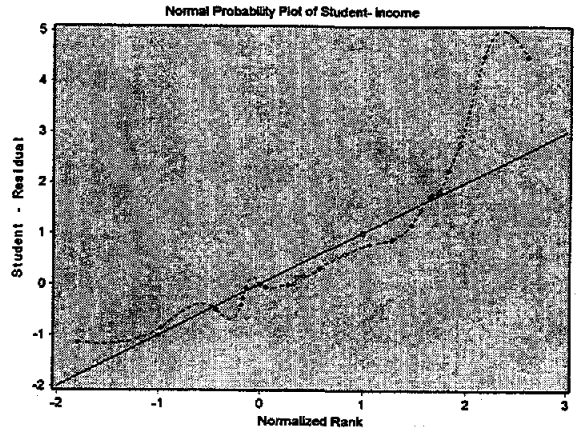
variability trimmed (5%) data, Two-side 95% Confidence level, etc. Further, the result of D'AGOSTINO- PEARSON OMNIBUS NORMALITY Test tells us more important information concerning the distributions of the data set.

	P-value for Kurtosis	P-value for Skewness	P-value-D'agostino-ominus
Crs	3.23E-11	0	0
Crtc	3.31E-09	0	0
Gymno	1.53E-06	3.56E-11	2.59E-15
Income	6.09E-08	5.04E-13	0
Level	7.09E-05	2.58E-06	5.91E-08
Age	0.029778	0.020883	0.0065
Fam	0.045385	8.89E-06	6.70E-06

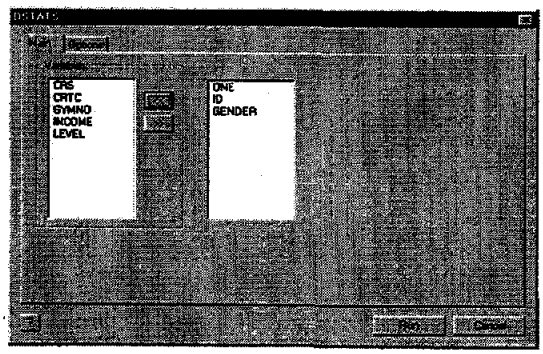
The significant Chi-Square and P-values for D'AGOSTINO-OMNIBUS tell us the distributions of Crs, Crtc and Income are not only skewed but also having long tails on the right hand side. It can also be verified by the following Normal Probability Plot of Students.

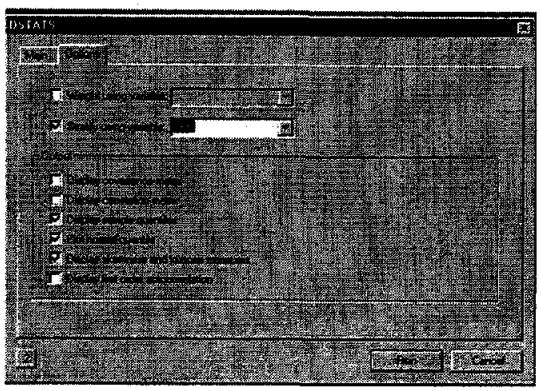






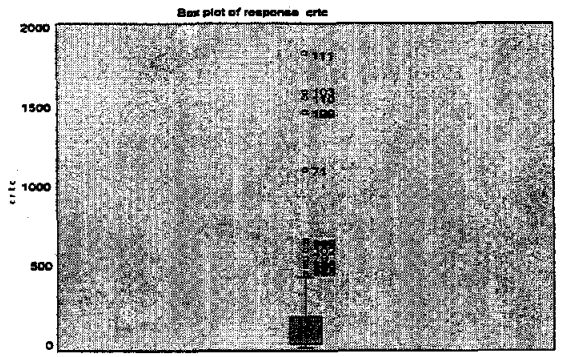
Some other statistics software, such as Limdep, can also provide the above detailed data description and those graphics including histogram, plot normal-quantile, etc. However, using Limdep, we have to keep seeking the appropriate windows and change inputs in order to get the complete result.

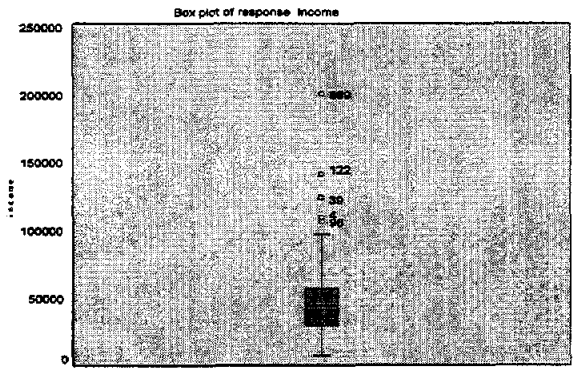




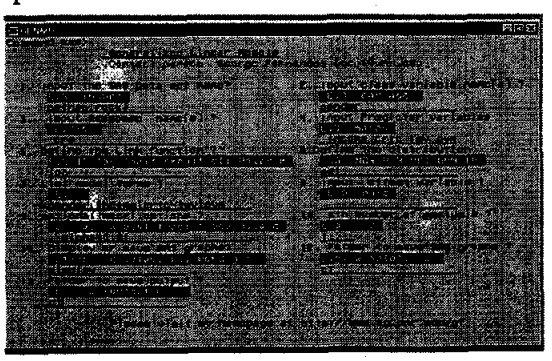
The time consuming repeated analysis and those confusing multiple windows limit the

application of Limdep. The SAS Univar macro requires several SAS modules: BASE, STAT, GRAPHICS and QC. Compared with Limdep, it gives us adequate automation and complete functionality. And most importantly for our CVM research, Univar macro gives us the convenience of outlier detection based on the following Box plot of response.





The Box plot combined with different values of STUDENT Residuals in the Univar output tell us which observations could probably be outliers. Based on the Univar result, we removed the potential outliers in the raw data. The cleaning work focuses on the variables of Income and Crtc because people's annual income and the travel cost to cave rock are expected to have larger effects on the trips that climbers make. Finally, we are left with 125 observations. This time, the SAS Genmod macro is used in parameter estimation.



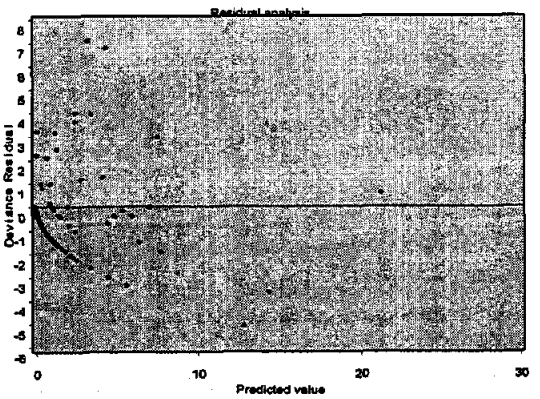
Estimation Result

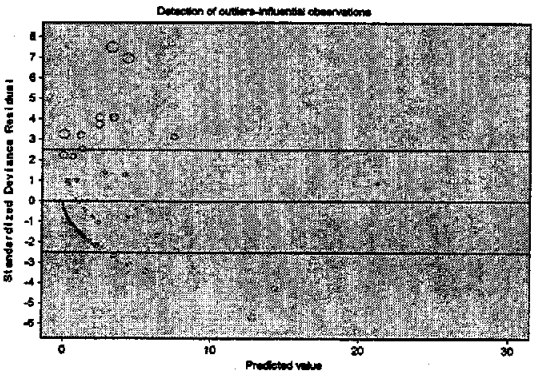
Parameter Estimation (Genmod with indicator variables)

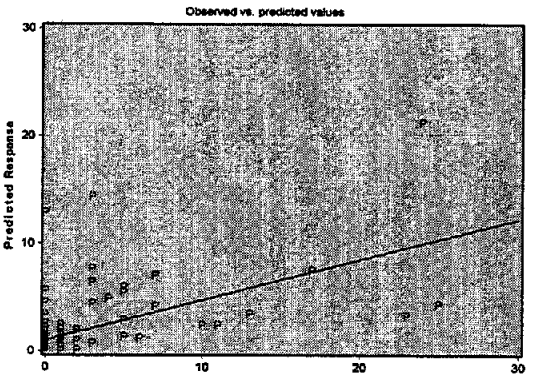
	d.f	Coff.	Std. Err	Chi-Square	Pr>Chi
Const	1	-5.5415	1.0031	30.5206	0.0001
Gender: male	1	0.7642	0.3193	5.7276	0.0167
Gender: female	0	0	0	.	.
crtc	1	-0.0083	0.0029	8.3423	0.0039
Income $1000	1	0.0041	0.0036	1.3053	0.2532
Crtc *income	1	0	0	0.4581	0.4985
Gymno	1	-0.0348	0.0134	6.7669	0.0093
Level	1	0.4978	0.0801	38.5699	0.0001
Gymno *level	1	0.0033	0.0011	8.903	0.0028
scale	0	1	0	.	.

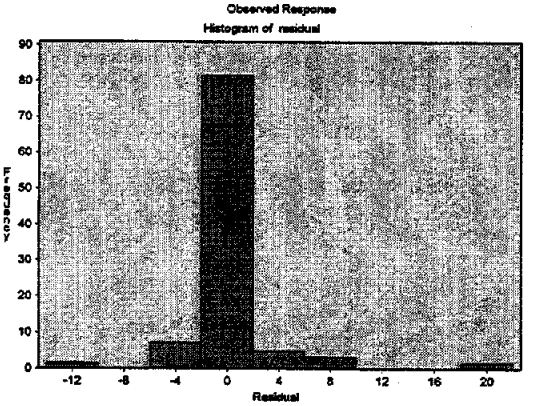
The analysis result shows the estimation of four continuous variables: Crtc, Income, Gymno, Climbing level and one dummy variable: gender. By inputting " Crtc|Income" in " model term " space, Genmod macro searches the combination effects that Crtc and Income will have on the climbing trips, so do the Gymno and Level . According to the Chi-Square and P-Value, most of the coefficients are significant. In the poisson model, the climber' WTP per-trip equals -1/crtc ≈ $120.48 . Totally the consumer surplus for 125 climbers in our survey equals $ 24,096.40.

The result of Genmod macro also provides several exploratory graphics which can help us judge whether and to which extent the chosen distribution are fit for the data set.







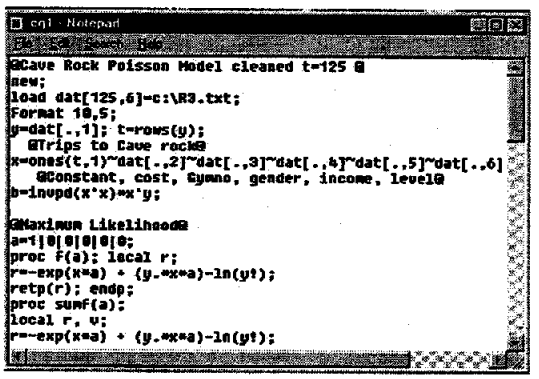


A fan shape pattern was found in the deviance residual plot between the residuals and the predicted values. This suggests that the residuals have unequal variance. The studentized residuals lie within 2.5 standard deviations. Similarly, significantly large DFFITS statistics are found. Therefore significant outlier or influential observations are present in this data. Thus the further research of the model is needed.

Conclusion

Compared with the traditional method using program code, for example GAUSS, the easy modification and user friendly interface in the macro-call window makes the SAS-Macro approach powerful and flexible. Cave rock survey gave us six continuous variables (Crtc, Age, Income, Family size, Climb level & Gym-climbing times) and two dummy variables-- Gender and Go/not go to gym climbing. Among those variables, some may have major effects on Cave rock climbing trips while some others may have rather small effects. In order to get the best and most reasonable WTP, researchers have to choose different variables and make many trials of analysis. Using SAS Macro, we only need to change the inputs in the above dialog window. Then, results and complete analysis will turn out very quickly.

Moreover, GAUSS requires higher ability in code writing, which makes it less suitable for average users than SAS Macro that only requires minimum training.



Because of the above advantages --- user-friendly approach, dynamic interface menu and most importantly, outlier detection --- SAS will be considered as the most powerful and popular statistical tool in non-market valuation research. SAS users can download the univar and genmod macro-call files and run these macros directly on the Internet by visiting and following instruction given on George Fernandez's home page at http://www.ag.unr.edu/gf.

Acknowledgements

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Contact with author at:

Yuanfang Lin

Department of Applied Economics & Statistics,
University of Nevada, Reno.
Mail Stop 204, Reno, NV89557

775-784-1344 (O)
yuanfang9@yahoo.com