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## The evolution of wilderness demand: investigating price, income, and other demographic effects with a quarter-century of data

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## Motivations

- Climate Change
- Forestry Management in genera
- Pergams and Zaradic's suggestion that nature based recreation was becoming less importan

Policy in the long run

- Many policy choices involve decisions that have ramifications across decades and centuries
- Even with stable preferences modern (Arrow et al) analysis suggests that declining discount rate structures may be preferred
- As suggested below evolving preferences will result in even more quickly declining discount rates for wildernesses
The role of evolving amenity demand in a present value context
- Simple Cross-Sectional: Present Value $=Z^{*} \exp (-\mathrm{rt})$
- Suppose Z grows through time exponentially : $\mathbf{Z}^{*} \exp (d t)$
- Then: Present Value $=Z^{*}(\exp (d t))^{*}(\exp (-r t))$

Or, Present Value $=Z^{*} \exp \left((d-r)^{*} t\right)$
Much like risk adjustments growth acts to change the discount rate on long lived projects
This research effort

- Project is about measuring a d
- Areas of interest are pristine wildernesses set aside for posterity
- Untouched wildernesses are always possible places for exploitation
-Wildernesses cannot be recovered if exploited, essentially development is irreversible
Basic Travel Cost Model
- Individual Linear Exponential Demand

$$
\lambda=\exp \left(P_{\mathrm{ijt}} \mathrm{~T}_{\mathrm{ijt}}, P_{\mathrm{ijt}}{ }^{*} * T_{\mathrm{ijt},}, Y_{\mathrm{ijf},} P_{\mathrm{ijf},}{ }^{*} T_{\mathrm{ijt}}, Z_{\mathrm{ift}}, \beta\right)
$$

- where $\lambda$ is the ith person's trips demanded of the $j$ th site in year $\mathrm{t}, \mathrm{Pijt}$ is
the travel cost to the jth site by the ith person in year $t$, Tij is the year of travel to the $j$ th site by the ith person in year $t$ (shifts the intercept through time), Pijt * Tij an interaction term between time and travel cost (shifts the demand slope through time), ), Yiit is the income of individual i in time $t$, Yijt * Tij an interaction term between time and income (allowing income
effects to shift through time), and the vector Z contains the characteristics
of site $j$ and $\beta$ is a vector of parameters to be estimated


## Welfare Measures

Seasonal Consumer Surplus $\quad \lambda(t) / \beta_{\text {travel cost }}(\mathrm{t})$
Per trip Consumer Surplus

$$
\begin{gathered}
\lambda(t) / \beta_{\text {travel coses }(t)}(1) \beta_{\text {travel }}^{\text {cosi }}
\end{gathered}
$$

## Data Briefly

Hiking permits collected between 1981 and 2004
Travel costs in \$2014
Demographic data from census (annually interpolated)

Econometric Results


Findings Briefly
$24.94 \%$ increase in value 1981-2004
Annual change in welfare of $0.71 \%$ per year
Present Value $=Z^{*} \exp \left((d-r)^{*} t\right)$

- Present Value $=$ Z*exp $((0.71-r) * t)$
-4\% becomes $3.29 \%$ - a non-trivial change
Much like risk adjustments growth acts to
change the discount rate
Will result in more wilderness projects than a cross-sectional analysis would support

Data study area and construction


Changes in Welfare


Changes in Income Elasticities


## Selected References

Arrow, K., M. Cropper, C. Gollier, B. Groom, G. Heal, R. Newell, W. Nordhaus,R. Pindyck, W. Pizer, P. Portney, T. Sterner, R.S.J. Tol, M. Weitzman. 2013. "Determining Benefits and Costs for Future Generations" Science Vol. $341: 349-350$. Pergams ORW , PA Zaradic 2008. Evidence for a fundamental and pervasive shift away from nature-based recreation. Proceedings of the National Academy of Sciences. 105(7):2295-2300.

