LECTURE 15: HOUSEHOLD PRODUCTION AND DISCRETE CHOICE

14.42/14.420

Hunt Allcott
MIT Department of Economics

Today's Class

- Valuation: Household Production
  - Travel Cost Method and Discrete Choice
    - One of my favorite parts of the course because it is both intuitive and more broadly useful in other branches of economics

- <u>Agenda</u>

1. Introduce the Question
2. Travel Cost Method
3. Multiple sites: The Logit Model
4. An Empirical Example

Mt. Monadnock

Image courtesy of ryptide on Flickr.

Mt. Monadnock Overview

- 3165 feet high
- Many hiking trails
- Spectacular views of Boston and Eastern Massachusetts
- Supposedly the second most popular mountain climb in the world after Mt. Fuji.
  - This is pure rumor, although I may treat it as fact on the final exam

- Policy question: How much is Mount Monadnock worth?
- Why do we care?
  - Keeping land protected for recreational use has opportunity costs: could be used for logging, farming, vacation homes, wind farms, etc.

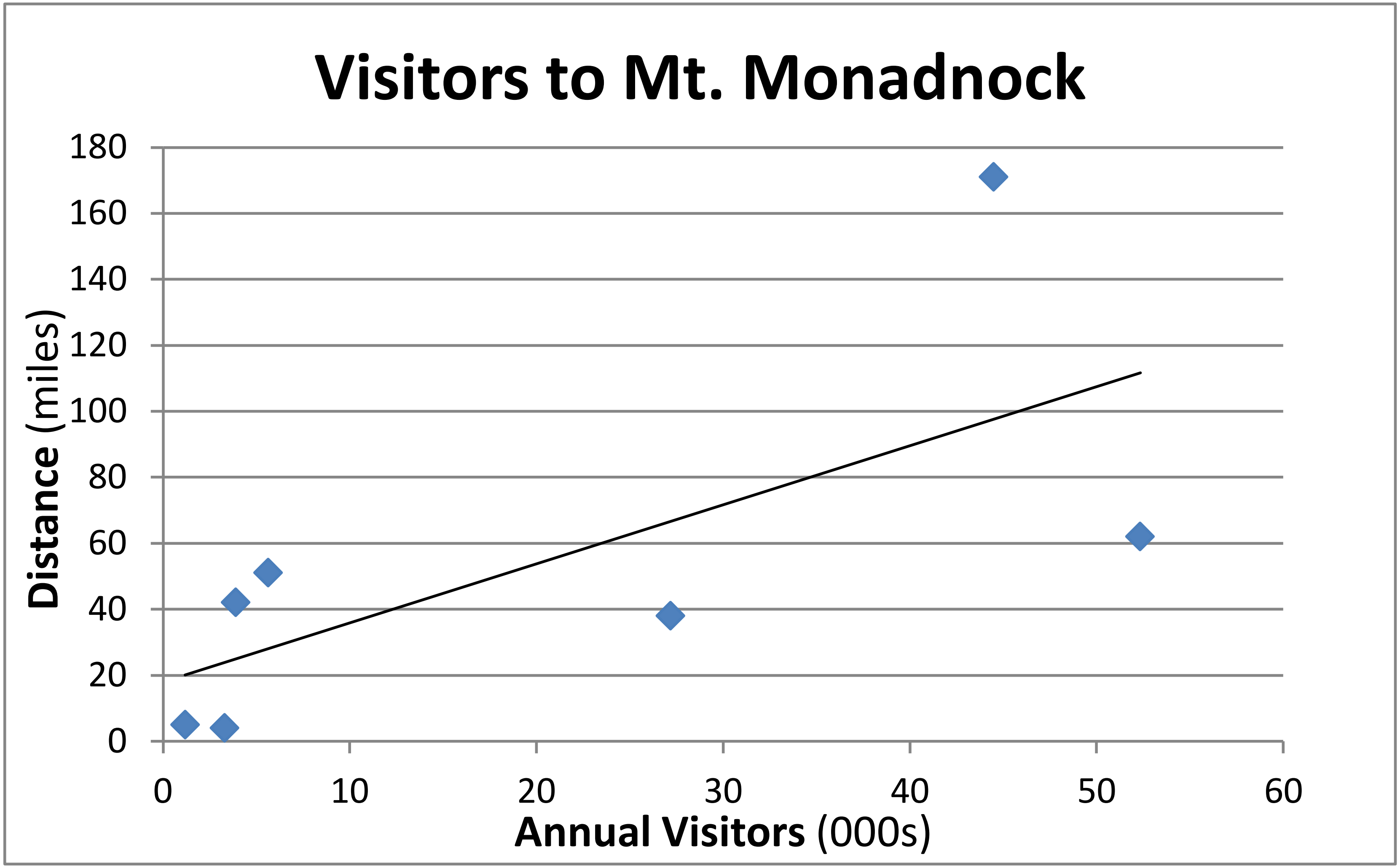
Travel Cost Method

- Intuition: Visiting a park takes time and money.
  - Time to drive, gas, etc.
  - Plus entrance fees.
- Implications:
  - The more awesome the park, the more I’m willing to give up to visit it.
  - The closer I live to a park, the more likely I am to visit it.
- We can use this to trace out a WTP curve for a park
  - Number of visitors from towns at different distances away
  - Distance to park gives variation in *price*
  - Variation in visitors gives variation in *quantity*

Travel Cost Method: Data for Mt. Monadnock

Town	Distance	Visitors/ Year (k)
Boston	62	52.34
Concord	38	27.1925
Jaffrey	4	3.3096
Dublin	5	1.18232
Amherst	51	5.6232
Northampton	42	3.89698
New York	171	44.5
Other		11.9554
Total		150

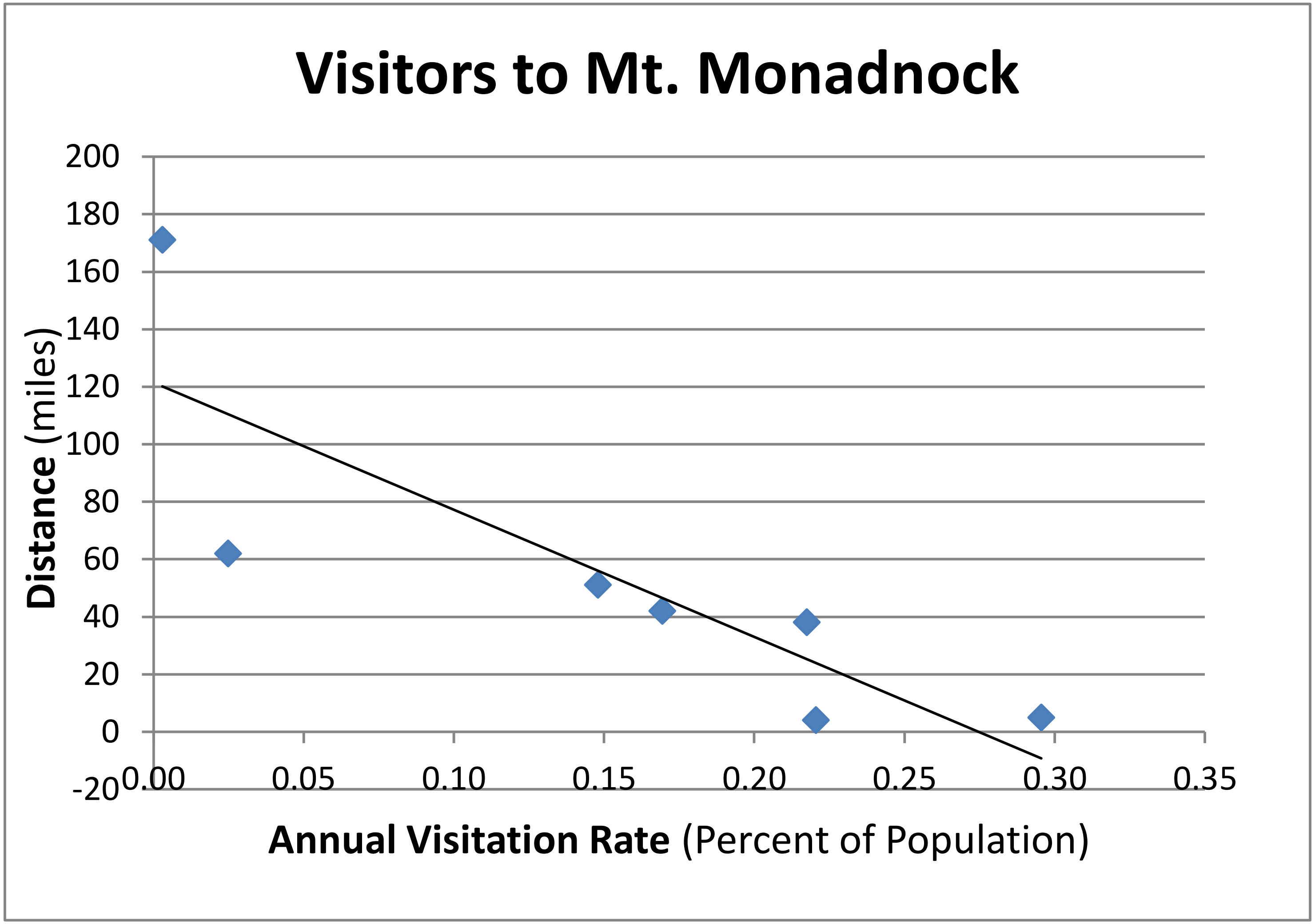
“Demand Curve” for Visitation?



Data for Visitors/Population

Town	Distance	Visitors/ Year (k)	Population (k)	Visitors/ Population
Boston	62	52.3	2100	0.02
Concord	38	27.2	125	0.22
Jaffrey	4	3.3	15	0.22
Dublin	5	1.2	4	0.30
Amherst	51	5.6	38	0.15
Northampton	42	3.9	23	0.17
New York	171	44.5	15000	0.00

“Demand Curve” for Mt. Monadnock



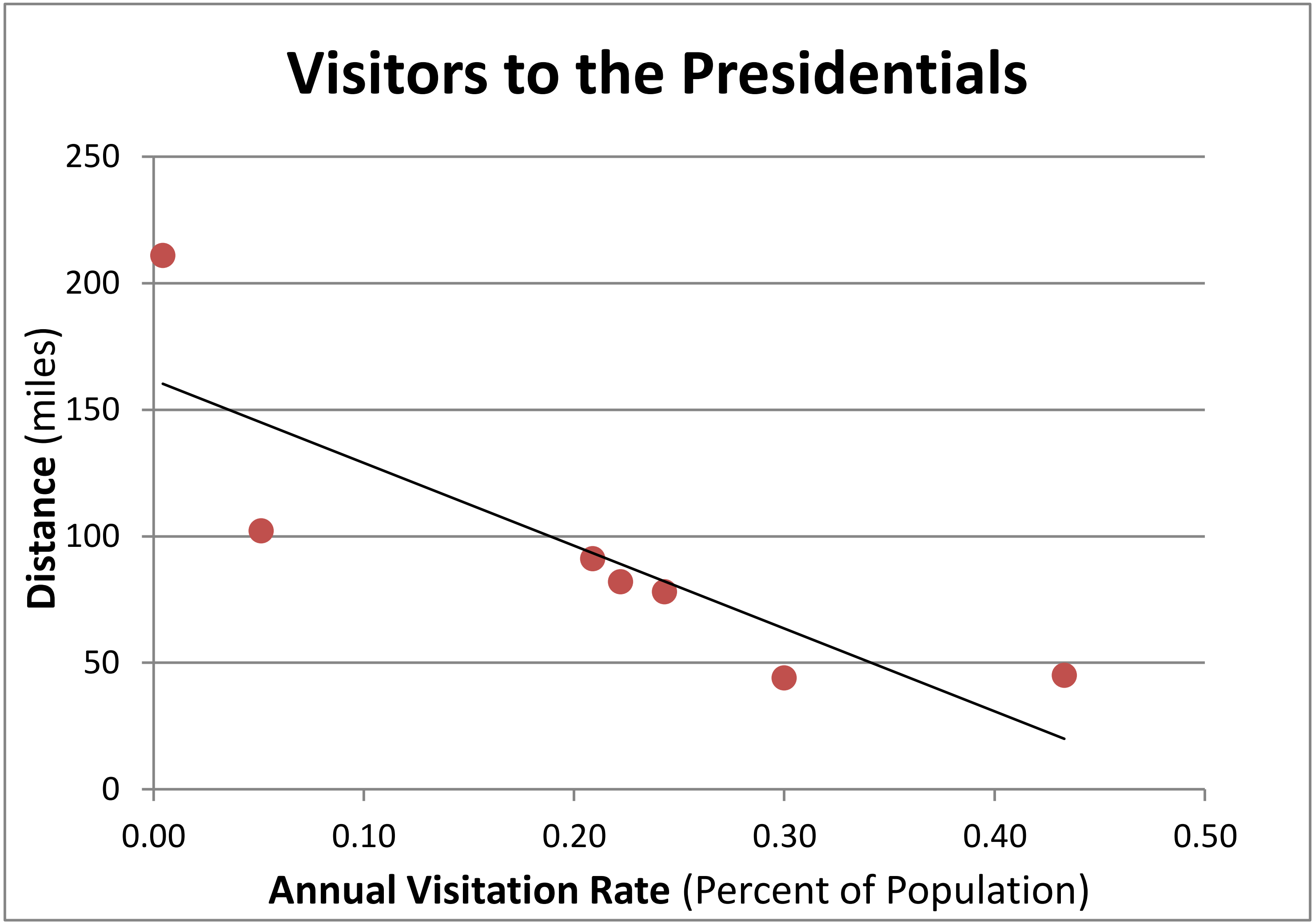
Additional Control: Income

Town	Distance	Visitors/ Year (k)	Population (k)	Visitors/ Population	Average Household Income ($k)
Boston	62	52.3	2100	0.02	80
Concord	38	27.2	125	0.22	67
Jaffrey	4	3.3	15	0.22	52
Dublin	5	1.2	4	0.30	54
Amherst	51	5.6	38	0.15	75
Northampton	42	3.9	23	0.17	73
New York	171	44.5	15000	0.00	

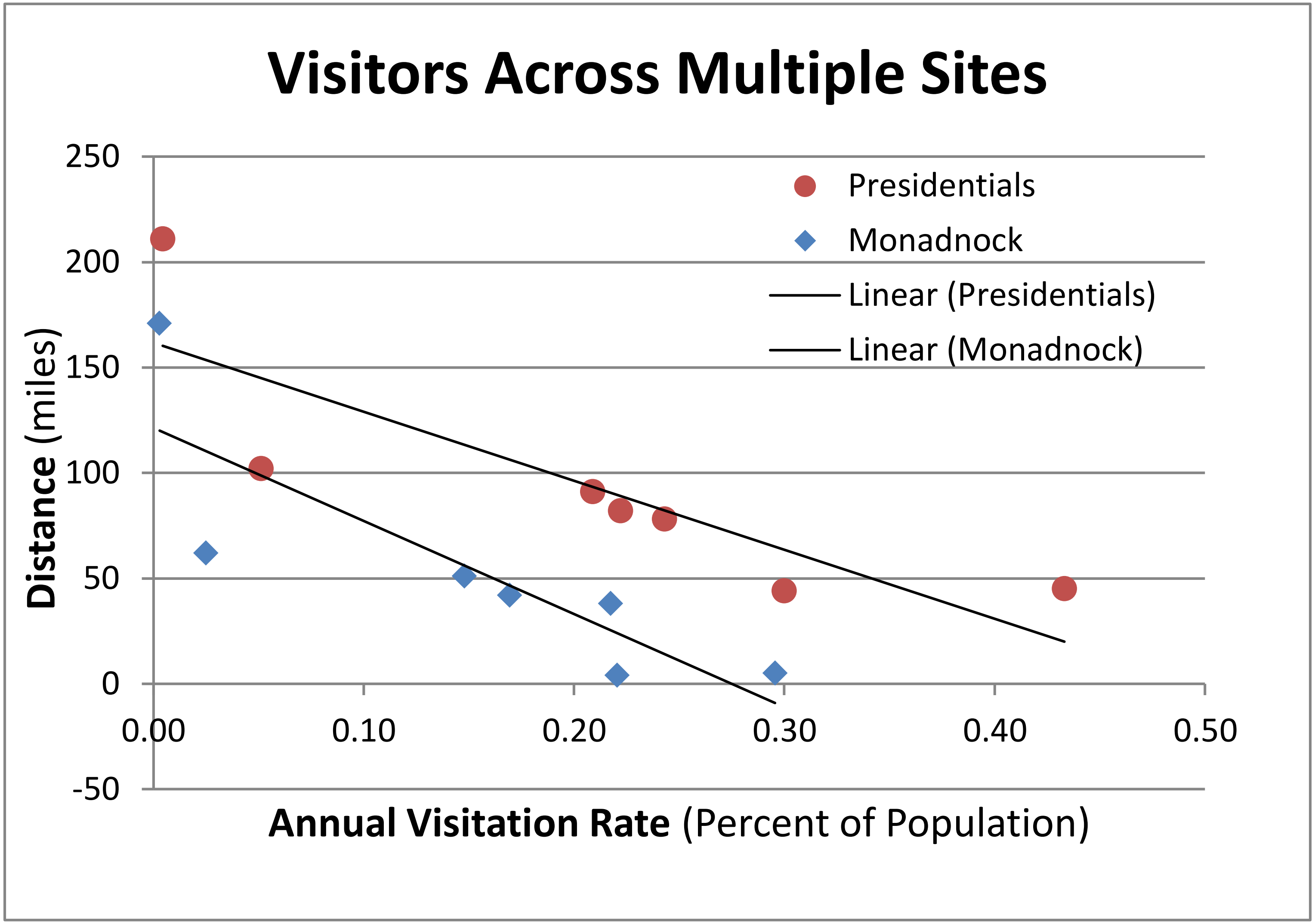
The Presidentials

Image courtesy of bawoodvine on Flickr.

Demand Curve for Visiting the Presidentials



Relative Demand Curves



Discrete Choice Models: Motivation

- The demand for Monadnock is really a function of the price of the Presidentials and of all other sites:

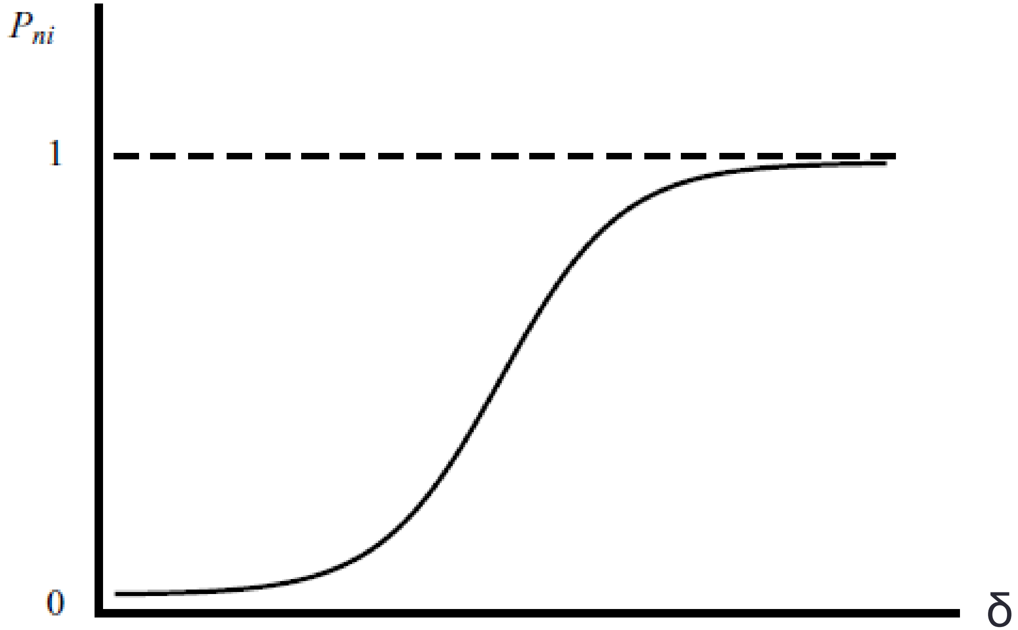
$$v_M = v_M\ (p_M, p_P, \ldots, y)$$

- Why is this important from a policy perspective? The welfare gains from protecting Monadnock depend on whether or not the Presidentials are also protected!

- Daniel McFadden developed an approach to this problem, for which he won the Nobel Prize in 2000.

Logistic Distribution

- Consider the choice of one site (Monadnock) vs. an outside option (any other Saturday activity, such as Nintendo at home).
- Normalize the utility of the outside option to 0.
- Assume that ε is distributed logistic: CDF $F(\varepsilon)=1 / (1+e^{-\varepsilon})$



The Discrete Choice Utility Function

- Random Utility
- Utility from visiting a site has a homogeneous portion δ and an unobserved portion ε.

- Characteristic Space
- Assume that consumers get utility from consuming park attributes, not consuming the park itself
- Characterize sites by these attributes that enter utility
- This reduces the problem to estimating demand for a small number of attributes.

Discrete Choice Estimation: Empirical Example

- Say we have data on parks, amenities, and visitation from different cities at different distances

- We can estimate with Ordinary Least Squares:

$\log s_j - \log s_0 = \beta X_j - \eta p_{vj} + \xi_j$

- Technical Note: This only works under the assumption that the variance in error terms εij is the same across different cities. Otherwise we need to use more complicated statistical techniques.

Dataset on Parks and Characteristics

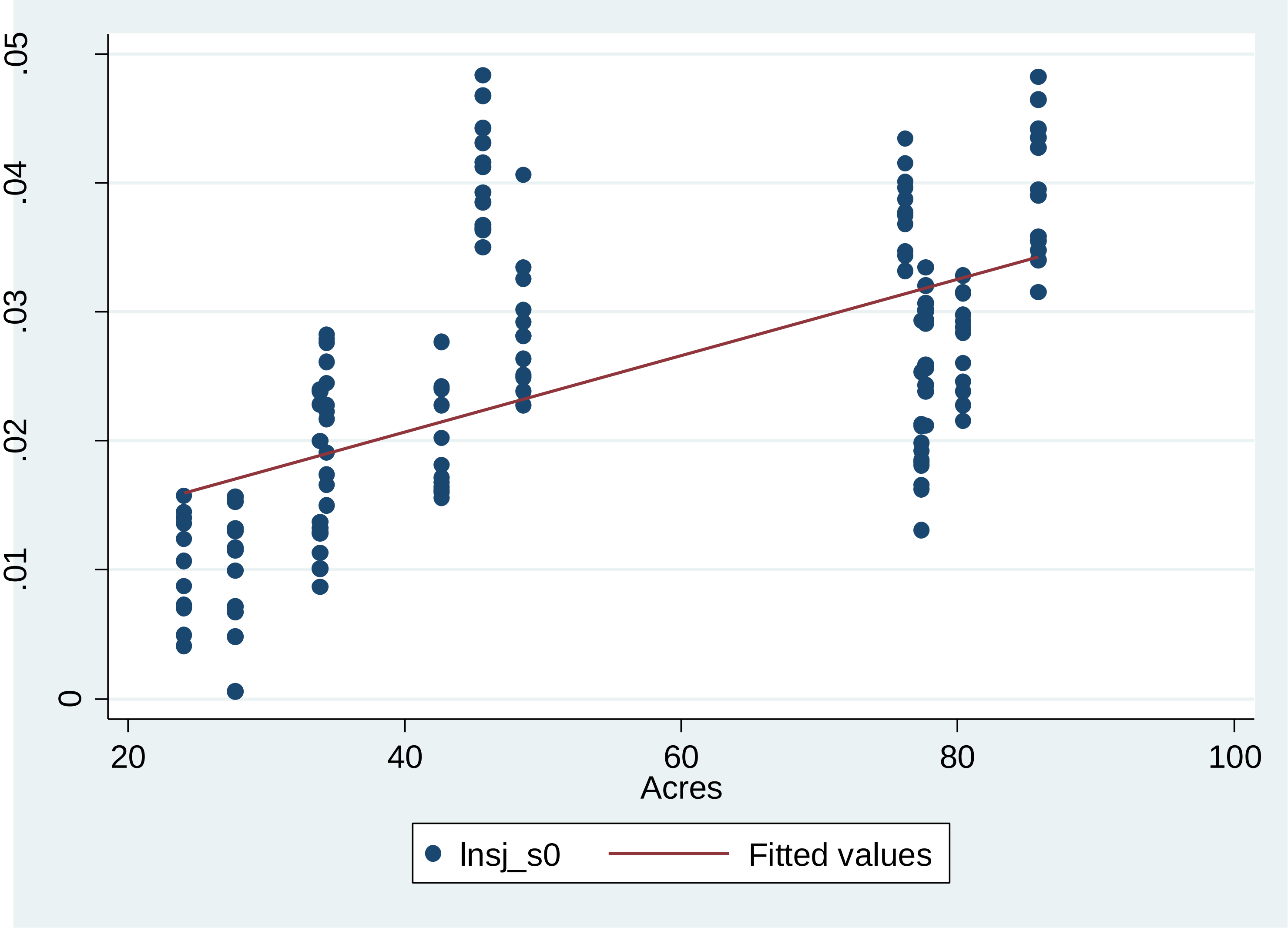
	ParkName	Acres	MaxHeight	TrailLength
1	Monadnock	48.58585	1.929516	.7791026
2	Presidentials	80.43579	2.533749	.0429583
3	Yosemite	33.86095	1.006582	.5626552
4	Grand Canyon	24.03083	1.082295	.1891081
5	Big Bend	42.68494	.0498568	.7989277
6	Blue Ridge Parkway	77.67514	1.11445	.526118
7	Lincoln Birthplace NHP	45.66599	3.839486	.977658
8	Chatthoochee River	76.24398	3.150046	.6018055
9	Boston Harbor Islands	77.40028	1.282077	.0378999
10	Fort Sumter	34.37448	2.199283	.5084499
11	Gates of the Arctic	27.76	.1591121	.448964
12	Governors Island NM	85.82054	2.589531	.6232119

Image by MIT OpenCourseWare.

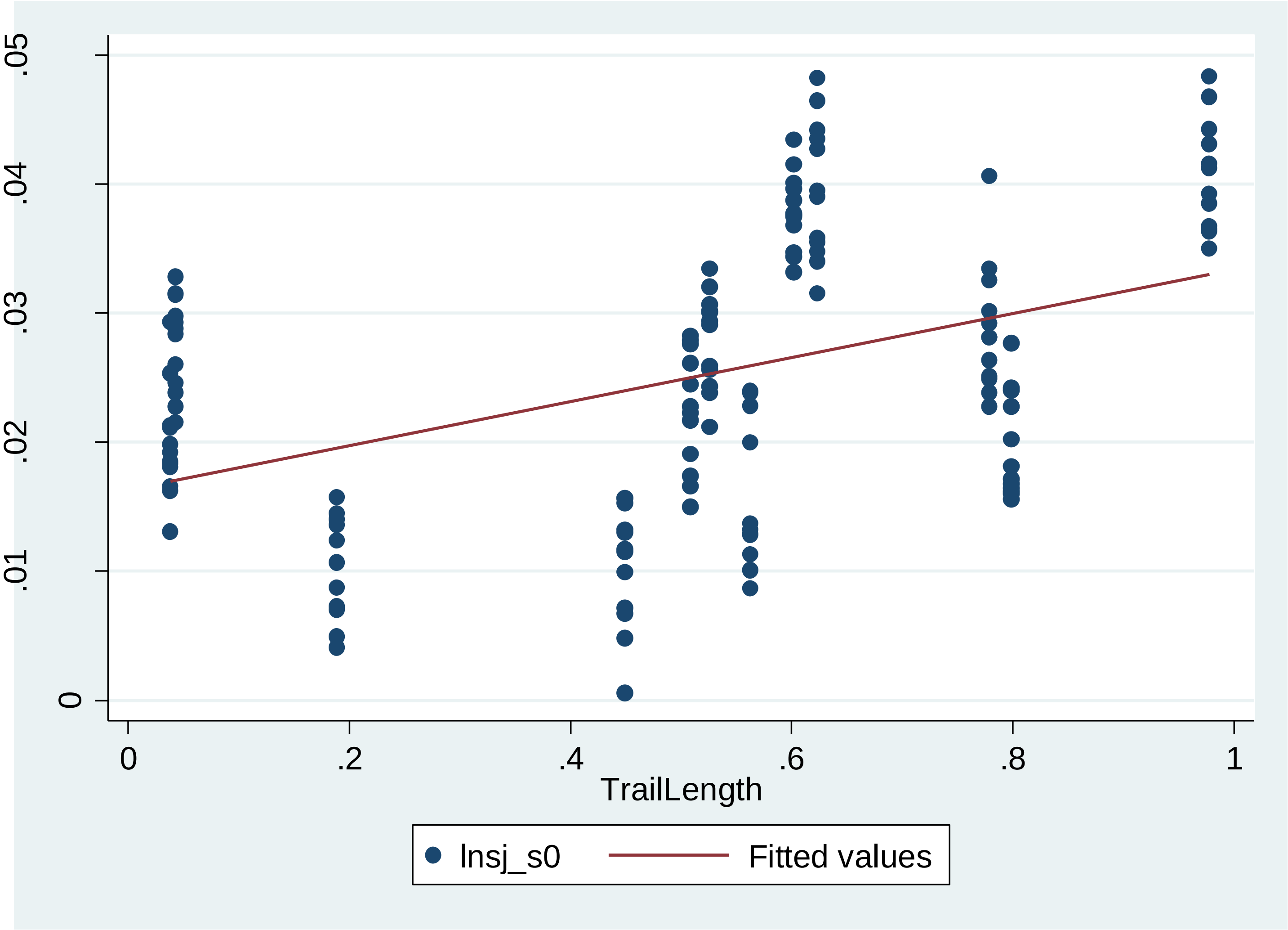
Dataset of Parks and Visitation

	ParkName	Source	Distance	TravelCost	Visitors	Insj_so	Acres	MaxHeight	TrailLength
23	Blue Ridge Parkway	NewYork	.277292	.0831876	23.2941	.0290542	77.67514	1.11445	.526118
24	Blue Ridge Parkway	Northampton	.48656	.145968	20.78289	.0259035	77.67514	1.11445	.526118
25	Boston Harbor Islands	Amherst	.7039295	.2111788	13.50256	.018042	77.40028	1.282077	.0378999
26	Boston Harbor Islands	Boston	.6155605	.1846681	14.56299	.0191954	77.40028	1.282077	.0378999
27	Boston Harbor Islands	Chicago	.6658635	.199759	13.95935	.018522	77.40028	1.282077	.0378999
28	Boston Harbor Islands	Concord	.8131885	.2439566	12.19145	.0183717	77.40028	1.282077	.0378999
29	Boston Harbor Islands	DC	.5171654	.1551496	15.74373	.0198453	77.40028	1.282077	.0378999
30	Boston Harbor Islands	Dublin	.020989	.0062967	21.69785	.0293142	77.40028	1.282077	.0378999
31	Boston Harbor Islands	Jaffrey	.6832927	.2049878	13.7502	.0165809	77.40028	1.282077	.0378999
32	Boston Harbor Islands	LA	.6123968	.183719	14.60095	.0211112	77.40028	1.282077	.0378999
33	Boston Harbor Islands	Lincoln	.2602195	.0780658	18.82708	.0253402	77.40028	1.282077	.0378999
34	Boston Harbor Islands	NewHaven	.4179728	.1253918	16.93404	.0213142	77.40028	1.282077	.0378999
35	Boston Harbor Islands	NewYork	.9557287	.2867186	10.48097	.0130727	77.40028	1.282077	.0378999
36	Boston Harbor Islands	Northampton	.7440961	.2232288	13.02056	.0162286	77.40028	1.282077	.0378999
37	Chatthoochee River	Amherst	.9267887	.2780366	24.86536	.0332249	76.24398	3.150046	.6018055
38	Chatthoochee River	Boston	.6268046	.1880414	28.46517	.0375198	76.24398	3.150046	.6018055
39	Chatthoochee River	Chicago	.6887722	.2066317	27.72156	.0367823	76.24398	3.150046	.6018055

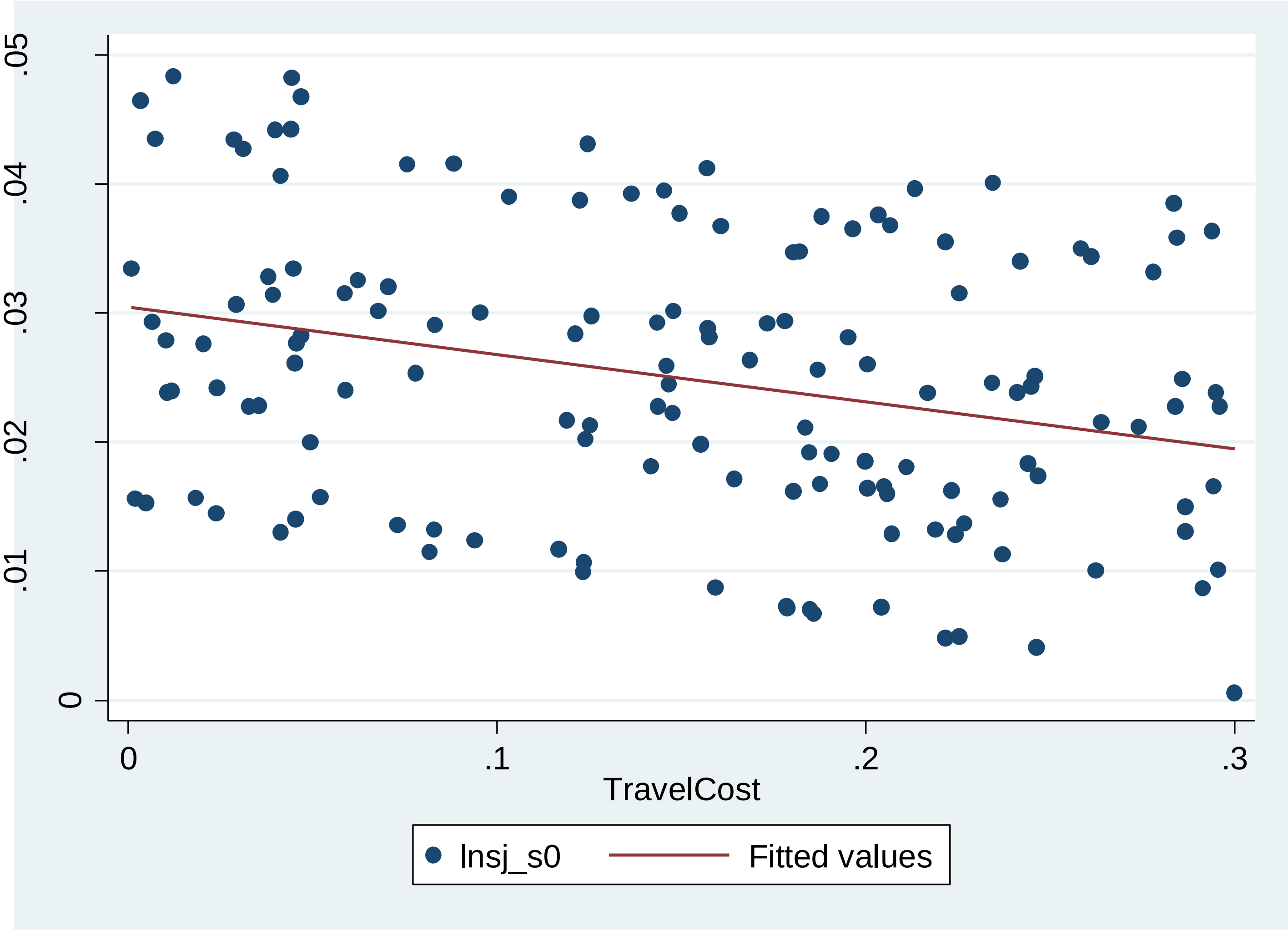
Unconditional Relationship Between Visitation and Amenities



Unconditional Relationship Between Visitation and Amenities



Unconditional Relationship Between Visitation and Travel Cost



Multivariate Regression

. reg Insj_s0 TravelCost Acres MaxHeight TrailLength, Robust

Linear regression

Insj_s0	Coef.	Robust Std. Err.	t	P > | t |	[95% Conf. Interval]	
TravelCost	-.0456047	.0016308	-27.96	0.000	-.0488291	-.0423803
Acres	.000249	6.92e–06	35.99	0.000	.0002353	.0002626
MaxHeight	.00507	.0001469	34.50	0.000	.0047795	.0053606
TrailLength	.016068	.000488	32.93	0.000	.0151031	.0170329
_cons	.0012306	.0004548	2.71	0.008	.0003313	.0021298

Number of obs =	144
F (4, 139) =	1564.70
Prob > F =	0.0000
R-squared =	0.9782
Root MSE =	.00166

Recap: Valuation with Revealed Preference

- We need to value environmental goods because we want to trade of costs of environmental protection with benefits.
- Problem: Public goods don’t have prices, so we can’t estimate a demand curve
- Instead, look at how the environmental good affects demand for a market good
- Two approaches to “revealed preference” valuation.
- Hedonics
  - Environmental good enters utility function directly.
  - Environmental quality directly affects the price of a market good
  - E.g. risk affects wages, pollution affects WTP for houses.
- Household Production
  - Utility derived by combining market goods and environmental goods.
  - Spending on complements or substitutes tells us the value of environmental good.
  - E.g. expenditures on travel to park, health care, or air pollution masks

Recap: Travel Cost Method and Discrete Choice

Travel Cost

- Demand curve needed to estimate welfare.
- Variation in prices and quantities needed for demand curve.
- Travel costs give variation in prices and quantities.

Discrete Choice

- When considering multiple sites, demand depends on prices of all sites.
- The logit model and characteristics space dramatically reduce the dimensionality of the problem.
- We can estimate how demand varies with prices and relevant attributes.
- This can be used for welfare analysis under counterfactuals: e.g. we remove a park, or add trails.
- This is broadly useful in environmental economics as well as in other economic applications.

Readings for Next Thursday

- Next time: Renewable and non-renewable resources
  - Are we running out of oil?
  - What is the best way to manage a fishery?
- This is heavy on math, but the math is very interesting and insightful
- No required readings: I will teach what is necessary for the exam
- Optional readings for people who want to deeply understand the math:
  - Sweeney
  - Slade and Thille

14.42 / 14.420 Environmental Policy and Economics
Spring 2011