ECNS 432
Ch. 14

- Skipping Chapter 13

Valuing Impacts from Observed Behavior: Indirect Market Methods

- Hedonic Pricing Method
  - Offers a way to overcome the omitted variables problem and self-selection bias that arise in relatively simple valuation methods
  - Can be used to value an attribute of a good, whenever its value is capitalized into the price of an asset
    - Q. What would be an example?
    - Ex. Attributes of a house

Hedonic Pricing

- Ex. Consider scenic views
  - Suppose we want to estimate the benefits of improving the (quality) "level" of a scenic view in an area by one unit (assume views are scaled from 1 to 10).
  - Obvious thing to do is estimate the relationship b/w individual house prices and the level of their scenic views.
  - Q. What is the problem with this?
  - Ans. Mkt. value of a house depends on a lot of other factors that are correlated with scenic views
    - Lot size (omitted variable)
    - People who live in houses with nice scenic views tend to value these views more than other people (self-selection problem)

Hedonic Pricing

- Hedonic pricing method attempts to overcome these problems by using two steps:
  - 1.) Estimate relationship b/w the price of an asset and all of the attributes (i.e. characteristics) that affect its value
    - i.e. derive the marginal effect of an attribute (e.g. an ↑scenic view) on the value of the asset, holding all else equal.
  - 2.) Estimate the WTP for the attribute
- From this info, we can calculate the ΔCS resulting from projects that improve or worsen the attribute

Hedonic Pricing

- Scenic view example
  - First, estimate relationship b/w house price, P, and all of its attributes…a model for this may look like

$$P = f(VIEW, SIZE, \mathbf{NBHD})$$

VIEW: quality of scenic view

SIZE: lot size

NBHD: vector of neighborhood characteristics

-crime

-school quality

-etc.

Hedonic Pricing

- The change in P from a unit change in an attribute is the ***hedonic price*** of that attribute

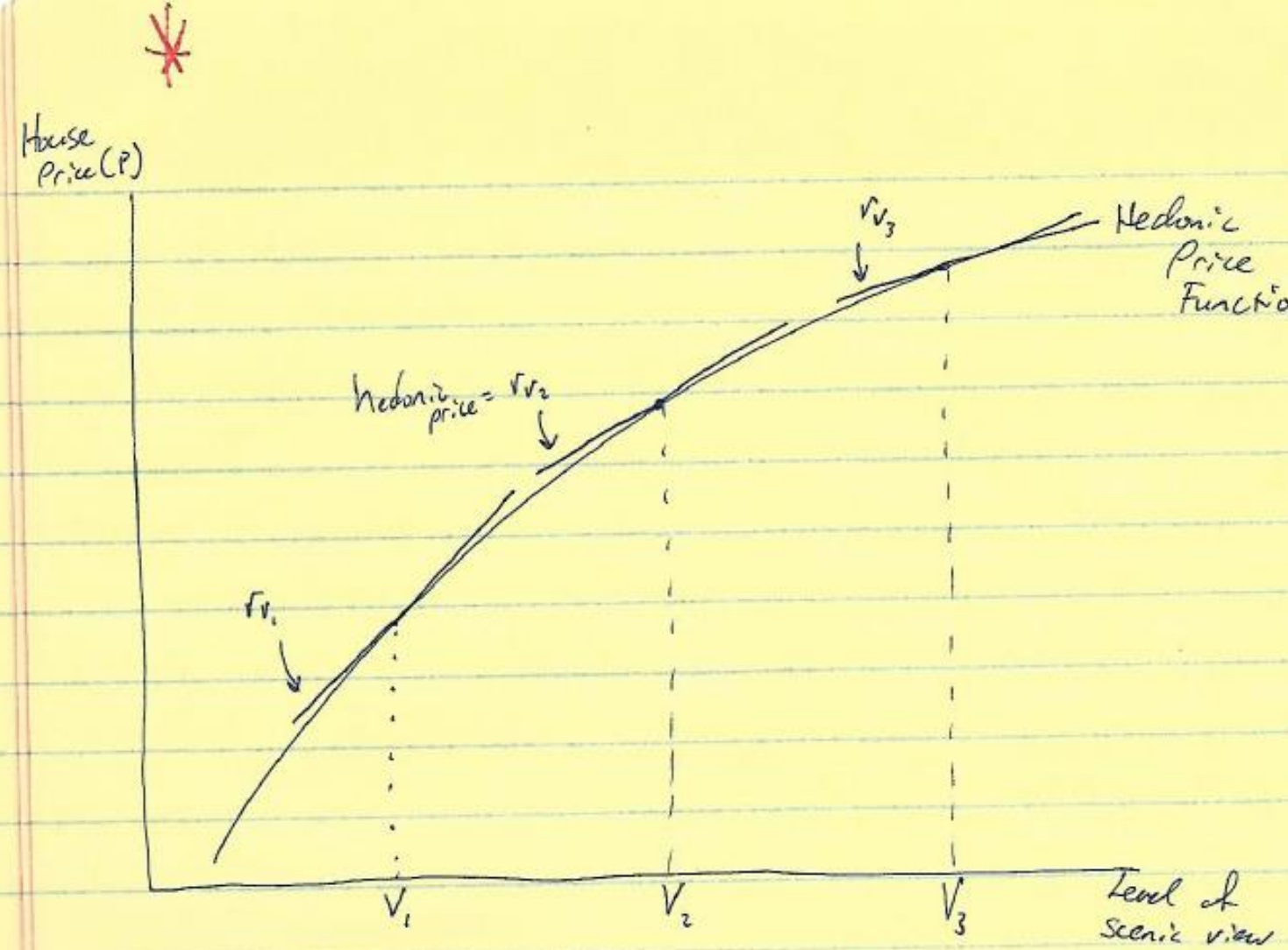
$$\partial P/\partial VIEW = r_v$$

-let r_v represent the hedonic price of scenic views

-i.e. the added cost of buying a house with a marginally better scenic view

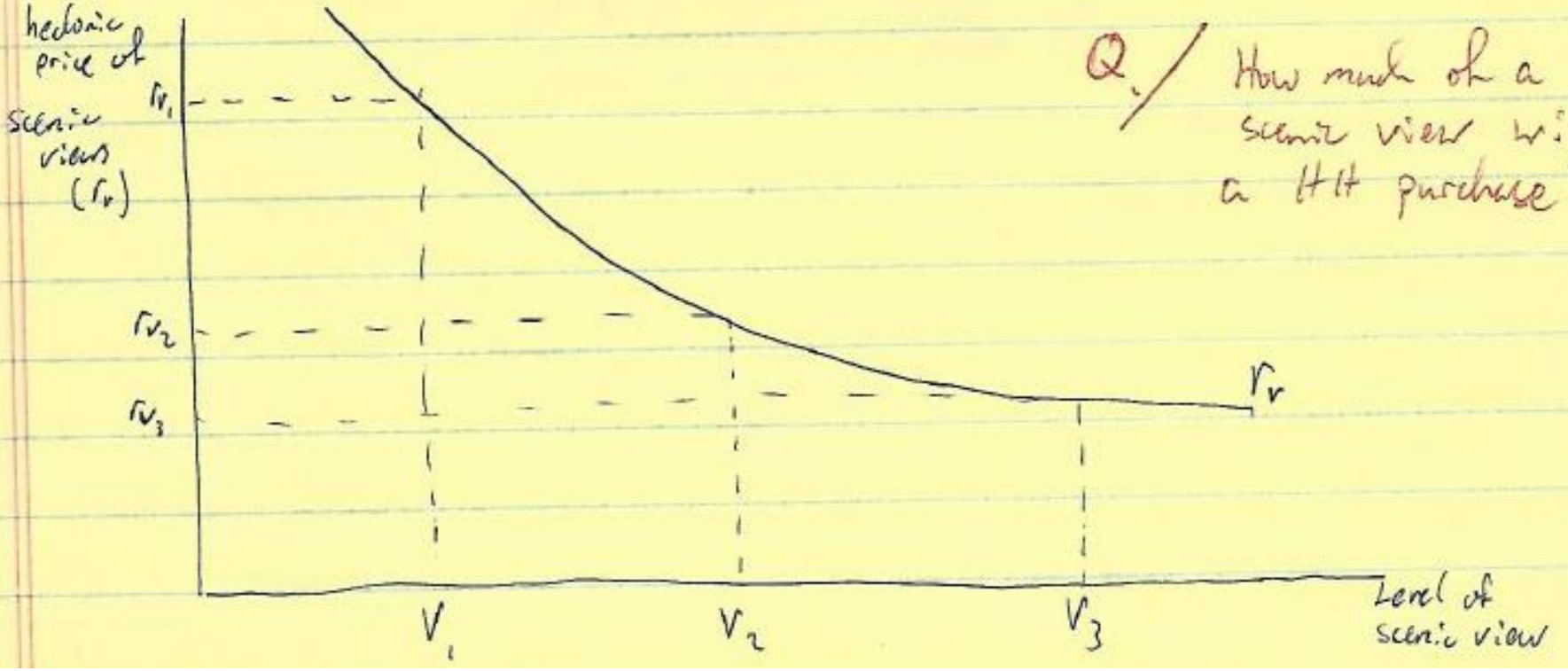
-Generally assume hedonic price fnc., P(), increases in its attributes at a decreasing rate (i.e diminishing marginal returns to a scenic view)

[insert graphs]



- Hedonic price of an attribute is the slope of the hedonic price fnc. evaluated at a particular level of that attribute.

- Note: plotting the hedonic price against the level of scenic view produces a downward sloping curve ⇒ MV of scenic view ↓ as level of view ↑



Q./ How much of a scenic view will a HH purchase?

Hedonic Pricing

- We have measured hedonic price fnc…so, we know what the market price is for scenic views.
  - But, what we really want to know is an individual's marginal willingness to pay for one more unit of a scenic view.
- In well-functioning market, utility maximizing HHS will purchase houses up to the point where their WTP for a marginal increase in each attribute equals its hedonic price
  - If we assume all HHs have identical incomes and tastes, this curve can be interpreted as a HH inverse demand curve for scenic views
  - But, HHs differ in their incomes and tastes…bringing us to our second step of the hedonic pricing method
- To account for differing incomes and tastes, we estimate a WTP (i.e. inverse demand) function for scenic views:

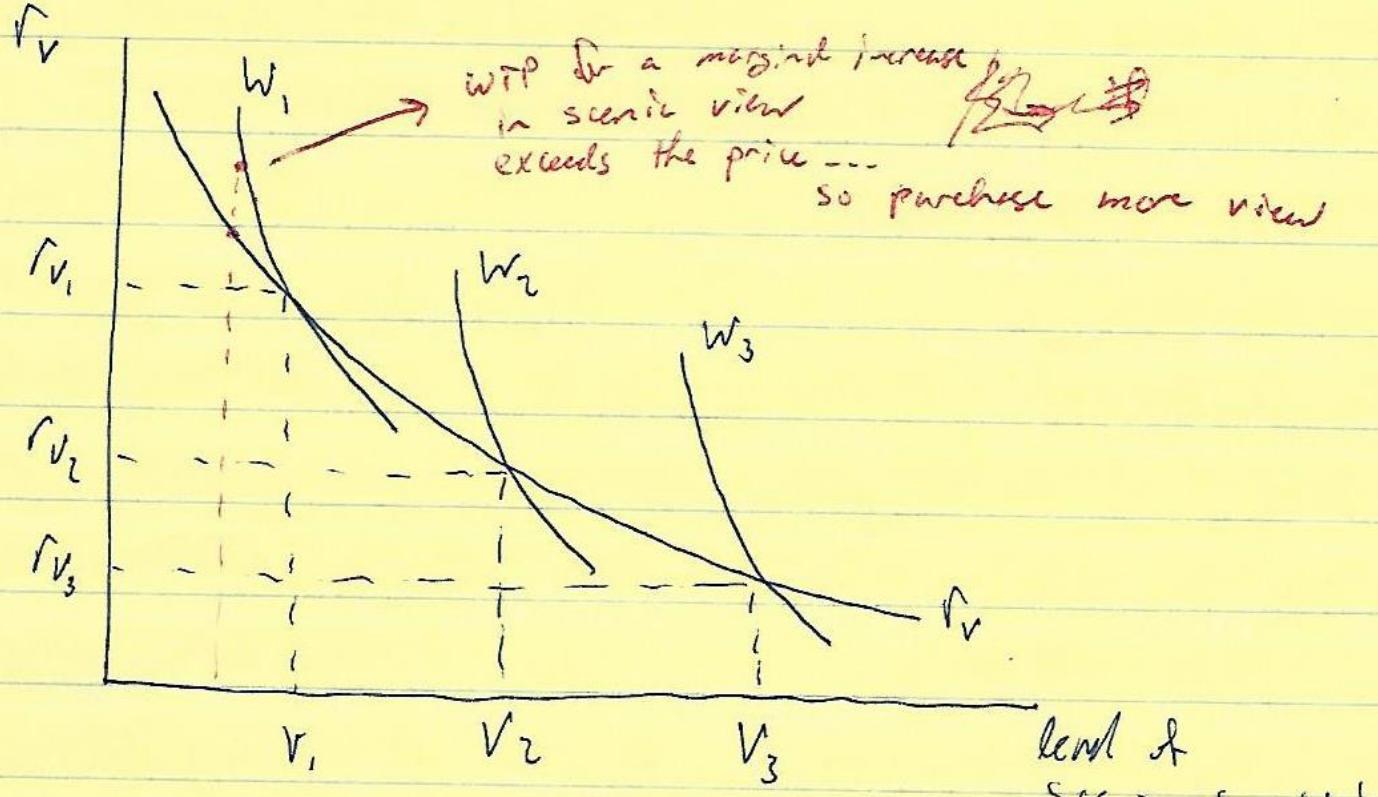
$$r_v = W(VIEW, Y, \mathbf{Z})$$

Y: HH income

Z: vector of HH characteristics

[insert graph]

- We can plot different HH WTP fncs. on our graph above



Hedonic Pricing

- Graph shows WTP fncs. for three different HHs
- Equilibria occur where these functions intersect the r_v fnc.
- When incomes and socioeconomic characteristics differ, the r_v fnc. is the locus of HH equilibrium WTPs for scenic views.
  - We translate the many observations on the choice of VIEW into a set of data on how marginal WTP varies with VIEW…and thus we can infer a marginal WTP function

Hedonic Pricing

- In sum,
  - We first observe the hedonic price function in a market.
  - Then, we measure the slope
  - Then, using this slope as a price of the characteristic, we measure the demand for the characteristic.
    - If the characteristic is a scenic view and the good is housing, we first note how the prices of houses vary with views.
    - We then compute how much those prices change when views change by one unit
    - This gives us a "price" of a view
    - We then note how people of different incomes (and tastes) react to different prices of views in choosing how much to consume.

[work old final exam problem]

3.) A city government is thinking about enacting a tree-planting initiative where government funds will be used to plant trees in the yards of their residents. Suppose you wish to estimate the benefits of this policy. Using the housing market and the hedonic price method you can accomplish this task. Suppose the price of a house is a function of two attributes and can be illustrated as follows:

$$P = F(trees, lot\_size)$$

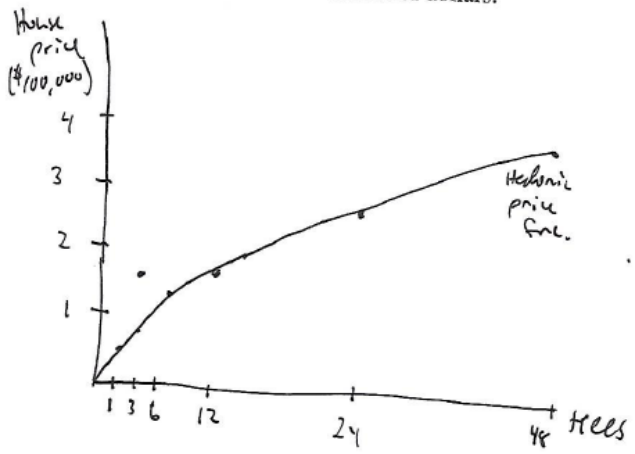
where *trees* denotes the number of trees on the plot and *lot_size* denotes the size of the plot in acres. Assume the hedonic price function takes a Cobb-Douglas form:

$$P = F(trees, lot\_size) = trees^{\alpha} lot\_size^{1-\alpha}. \quad \text{where } 0 < \alpha < 1$$

a.) (7 points) Assuming $\alpha = 0.5$ and for houses on 0.25 acre plots, graph the price function for the following values of *trees*:

$$trees = 1,\ trees = 3,\ trees = 6,\ trees = 12,\ trees = 24,\ trees = 48.$$

Make sure to label your graph (this includes both of the vertical axis and the horizontal axis). Assume prices are in, say, hundreds of thousands of dollars.



- $P = F(1, .25) = (1)^{.5}(.25)^{.5}$
  $= \$0.5$
- $P = F(3, .25) = (3)^{.5}(.25)^{.5}$
  $= (1.732)(.5)$
  $= \$.866$
- $P = F(6, .25) = (6)^{.5}(.25)^{.5}$
  $= \$1.225$
- $P = F(12, .25) = (12)^{.5}(.25)^{.5}$
  $= \$1.732$
- $P = (24, .25) = (24)^{.5}(.25)^{.5}$
  $= \$2.449$
- $P(48, .25) = (48)^{.5}(.25)^{.5}$
  $= \$3.464$

b.) (10 points) Using calculus, prove that the hedonic price function has the property of diminishing marginal returns to *trees*.

- Fnc. is increasing at a decreasing rate:

$$P = (trees)^{\alpha}(lot\_size)^{1-\alpha}$$

$$\frac{\partial P}{\partial trees} = \underset{+}{\alpha}\,\underset{+}{(trees)^{\alpha-1}}\,\underset{+}{(lot\_size)^{1-\alpha}} > 0$$

$$\frac{\partial^2 P}{\partial trees^2} = \underset{+}{(\alpha)}\,\underset{-}{(\alpha-1)}\,\underset{+}{(trees)^{\alpha-2}}\,\underset{+}{(lot\_size)^{1-\alpha}} < 0$$

c.) (7 points) Again assuming that $\alpha = 0.5$ and for houses on 0.25 acre plots, what is the hedonic price associated with planting one more tree given an initial level of trees of *trees* = 1? What about for *trees* = 3, *trees* = 6, *trees* = 12, *trees* = 24, and *trees* = 48?

$$r_* = \frac{\Delta P}{\Delta trees} = \text{hedonic price}$$

$r_{*_1} = (.5)(1)^{(.5-1)}(.25)^{(1-.5)} = (.5)(.5) = \$.25$

$r_{*_3} = (.5)(3)^{(.5-1)}(.25)^{(1-.5)} = (.5)(.577)(.5) = \$.144$

$r_{*_6} = (.5)(6)^{(.5-1)}(.25)^{(1-.5)} = (.5)(.408)(.5) = \$.102$

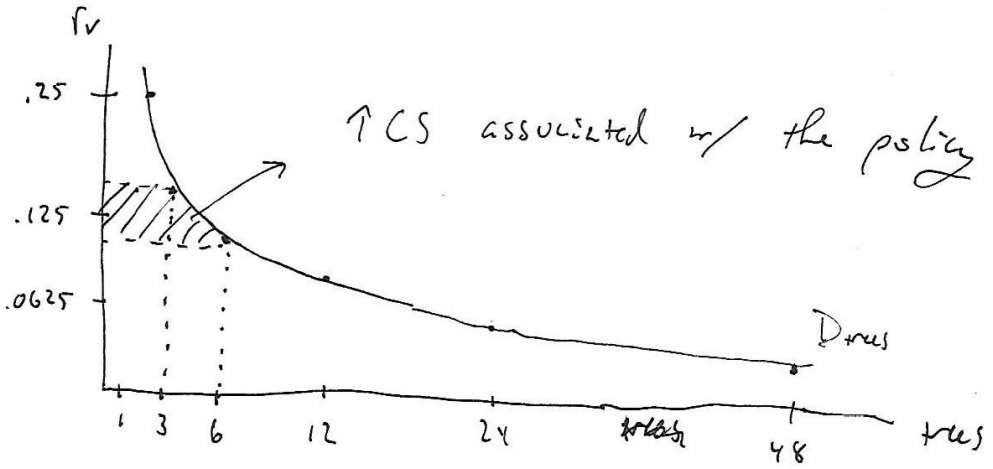
$r_{*_{12}} = (.5)(12)^{-.5}(.25)^{.5} = (.25)(.2887) = \$.072$

$r_{*_{24}} = (.25)(.2041) = \$.0510$

$r_{*_{48}} = (.25)(.1443) = \$.0361$

for HHs on ¼ acre plots.

d.) (8 points) Given your values from part c.), graph a demand curve for trees. Now, suppose the city government's specific initiative is to plant three trees in everyone's yard (regardless of how many trees the household may already have had). Show on your graph the benefits associated with this policy for all households who originally had *trees* = 3 before the policy was put into effect.



Ex. Demand for Air Quality in Boston

- Classic study by Harrison and Rubinfeld (1978) on demand for environmental quality
- Problem: Quantify benefits from tightening auto emissions control regulations for nitrogen oxides in Boston.
- They adopt the two-step procedure described in previous section.
- Using marginal WTP function for nitrogen oxides, they calculated benefits of the cleanup for average HH

Ex. Demand for Air Quality in Boston

- First, they estimated hedonic price equation for housing in Boston
  - Goal: explain the price of houses
  - Data drawn from U.S. Census at the census-tract level (several city blocks)
    - For each tract, they know

      -median price of owner-occupied houses

      -structural variables (e.g. ave. number of rooms in houses)

      -several neighborhood variables (e.g. crime rate)

      -variables reflecting accessibility (e.g. distance to one of five employment centers)

      -an air pollution variable (i.e. annual average concentration of nitrogen oxide)
    - Used data across 506 census tracts in Boston
  - With these data, were able to econometrically estimate a hedonic price fnc

P(**structural vars., neighborhood vars.,** …, nitro oxide)

Ex. Demand for Air Quality in Boston

- Remember, hedonic price fnc is not a demand function (simply indicates how housing prices vary when characteristics change)
  - Housing prices are determined by the interaction of supply and demand
- But, housing price function allows us to compute the *marginal price of nitrogen oxides* as reflected in house prices
  - This is the slope of the house price function with respect to nitrogen oxide concentrations
  - The authors are able to compute this marginal price, denoted *w*.
- The second step is to estimate the demand for nitrogen oxides…they posit a demand function of the form

$$w = \beta_1 NO + \beta_2 Y$$

where NO is nitrogen oxide pollution levels and Y is HH income

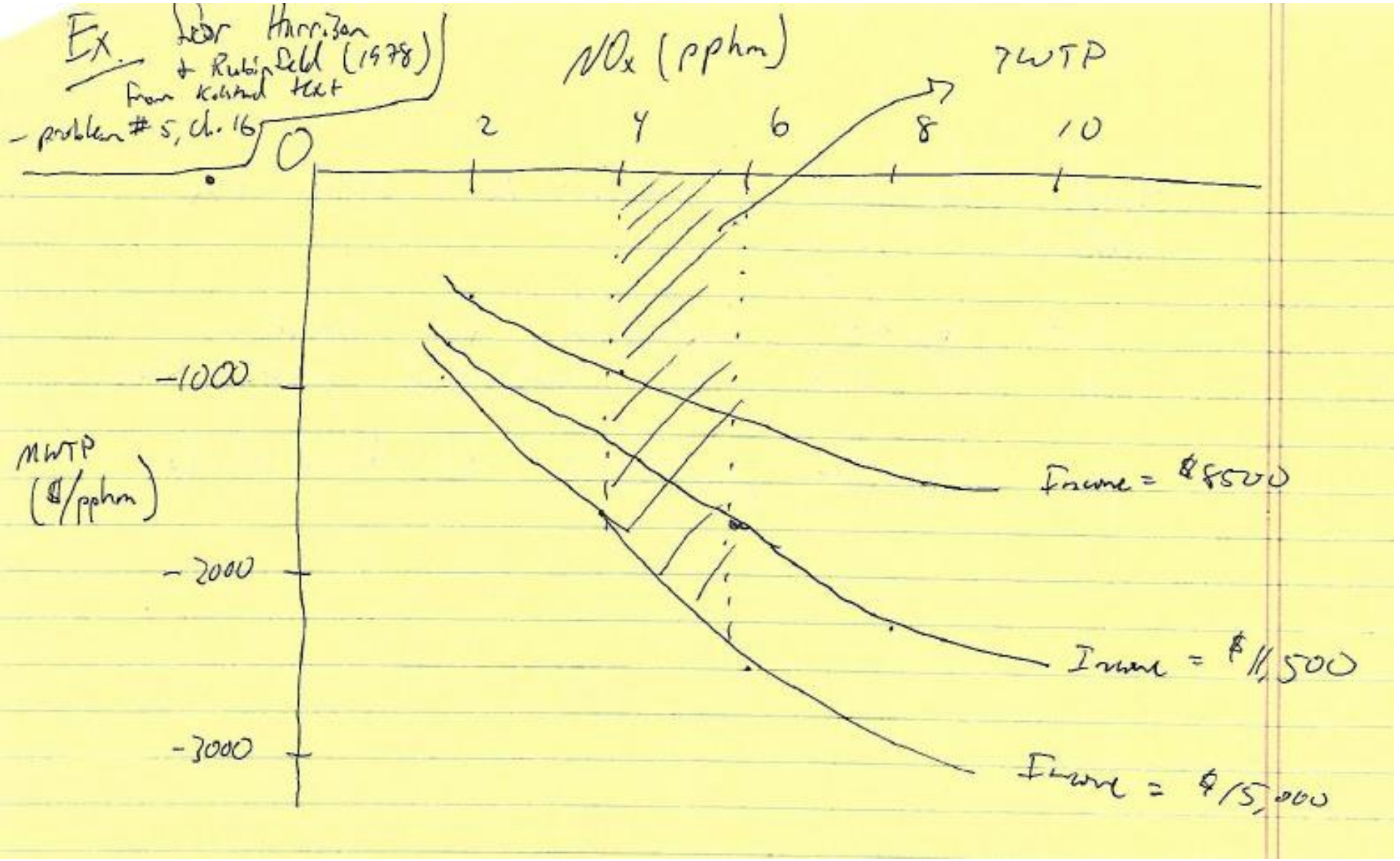
Ex. Demand for Air Quality in Boston

- Authors estimated this equation over the sample of 506 census tracts to obtain an equation for the marginal WTP for air pollution.
- Based on their estimations, they were able to calculate marginal WTP functions for different types of households

[insert graph based on their data]

- From this, we can calculate policy relevant benefit measures…from graph we can calculate total WTP for, say, a HH earning $15k per year of reducing nitro oxide levels from 6 to 4 parts per hundred million

[show total WTP graphically]


Ex. Lear Harrison & Rubinfeld (1978) from Kennard text
problem # 5, ch. 16
NOx (pphm)
2
4
6
8
10
MWTP
0
-1000
-2000
-3000
MWTP ($/pphm)
Income = $8500
Income = $11,500
Income = $15,000

Hedonic Pricing

- Some problems with Hedonic models
  - 1.) People must know and understand the full implications of, for example, the externality
    - Ex. To value pollution, HHs should know prior to house purchase, the level of pollution exposure and how different levels of pollution affect health
  - 2.) Important to include correctly measured variables, as opposed to more readily available but incorrect proxies
    - Ex. Year of house construction may be poor proxy for house quality
  - 3.) Should be sufficient variety in houses such that HHs can find a house that permits them to reach an equilibrium
    - Ex. A problem if a HH wants a small, pollution-free house, but all houses in pollution free areas are large

Hedonic Pricing

- 4.) If expensive houses are large and located mainly in areas free of pollution, but cheap houses are small and located mainly in polluted areas, then it would be tough to estimate separate hedonic prices for pollution and size
- 5.) The method assumes market prices adjust immediately to changes in attributes and in all other factors that affect D or S.