Non-Market Valuation

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Presentation Outline

Red Plenty

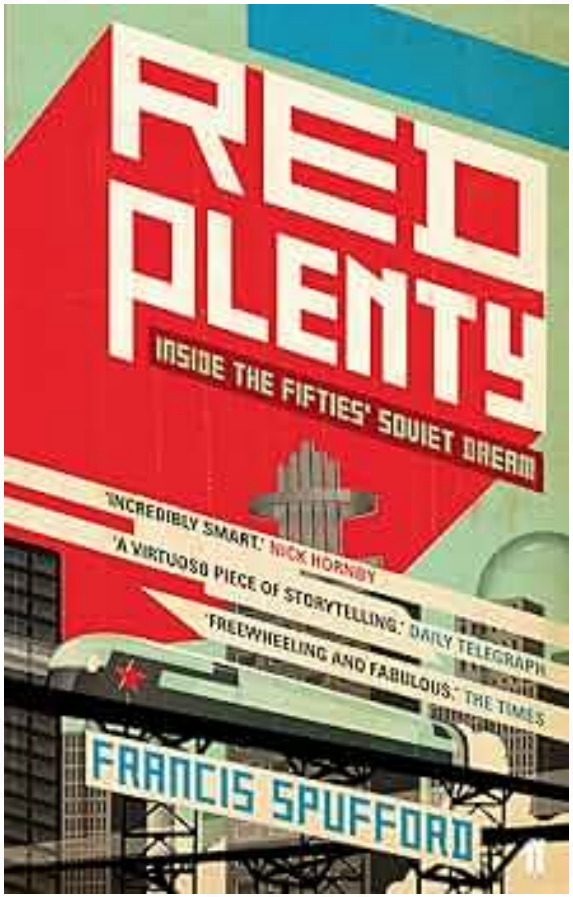

Figure 1: Only one Soviet Nobel Prize Winner.

Why we need Non-market Valuation

- Most goods in environmental economics do not have markets
- There is no market for clean air or a beautiful landscape
- No market exists for an undamaged climate
- Sometimes the participants of interest are not neccecarily consumers

Total Economic Value Equation

- Total economic value refers to value derived from a resource
- What is it truly worth? How should we think about this?

Total Economic Value Equation

- Total economic value refers to value derived from a resource
- What is it truly worth? How should we think about this?
  - Use value: Direct use (consumption and non-consumption) and indirect use (biodiversity, water purification)
  - Non-use: existence or bequest value, the value of the resource continuing to exist
  - Option value: ability to use the resource in the future

$$TEV = UseValue + NonUseValue + OptionValue \tag{1}$$

Total Economic Value

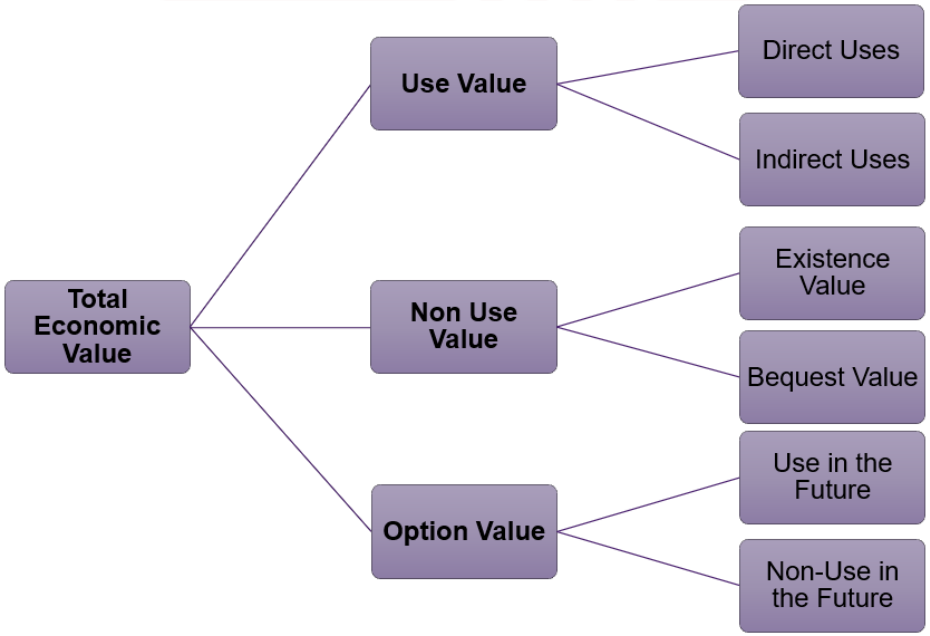

Figure 2: Caption

Types of Goods

	Excludable	Non-Excludable
Rivalrous	**Private Goods** Food, clothing, cars	**Common Goods** Fish, timber
Non-Rivalrous	**Club Goods** Swimming pools, cable TV, toll roads	**Public Goods** Street lighting, air, national defense

Figure 3: Caption

Non-market Methods

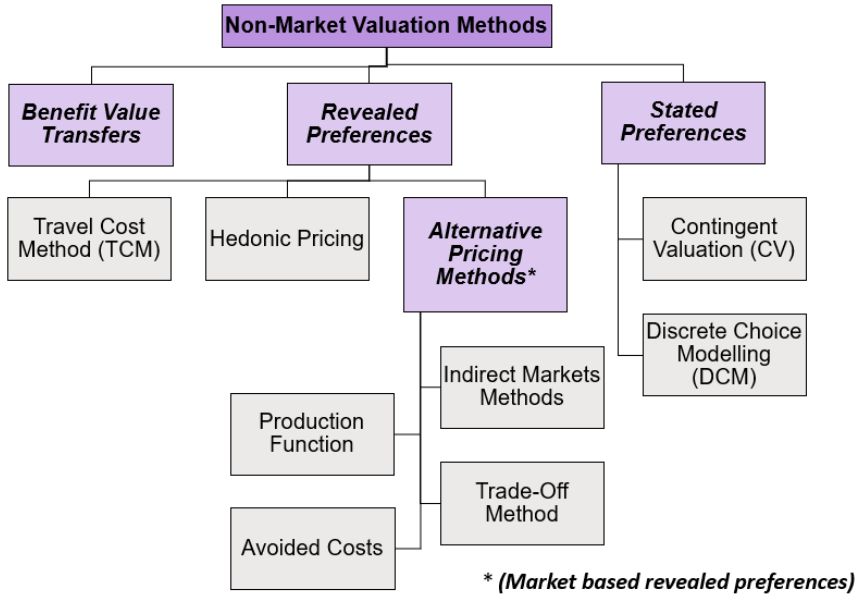

Figure 4: Caption

Benefit Value Transfers

Definition: The benefit value transfer method estimates the economic value of a non-market good or service by applying valuation results from existing studies conducted in a similar context.

Key Features:

- Relies on transferring valuation estimates rather than conducting new primary studies.
- Can involve transferring mean values, functions, or entire models.
- Requires careful consideration of the similarity between the study site (where the original valuation was done) and the policy site (where the value is applied).

Advantages:

- Cost-effective and time-efficient compared to primary data collection.
- Useful for preliminary analyses or when resources are limited.

Willingness to Pay

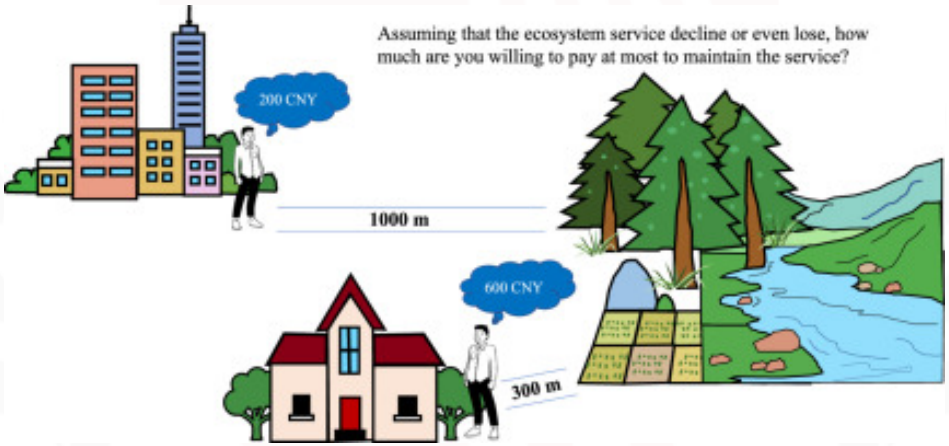

Figure 5: Is this the right way to think about willingness to pay?

Revealed Preference vs Stated Preference

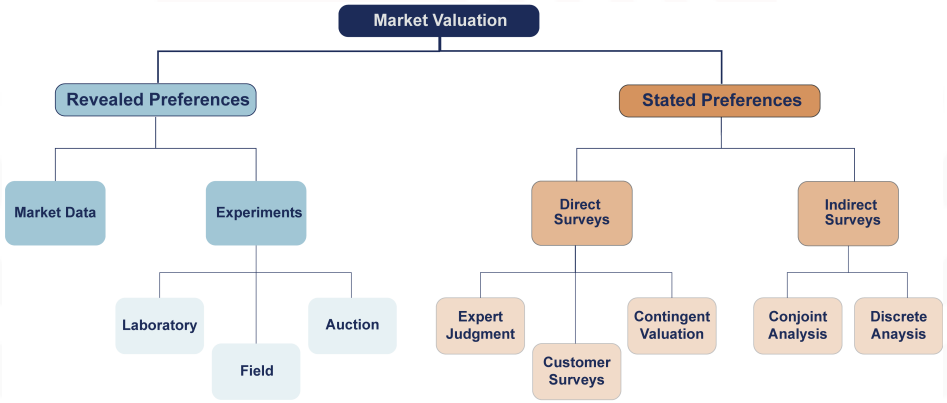

Figure 6: So many choices on valuation...

What Are Revealed Preference Methods?

Definition: Revealed Preference (RP) methods infer the value of non-market goods and services based on individuals' actual behavior in real-world market transactions.

Key Features:

- Uses observed choices in markets that are directly or indirectly related to the good or service of interest.
- Assumes that individuals' behavior reflects their preferences and underlying value for the good.
- Relies on actual market data rather than hypothetical scenarios or surveys.

Travel Cost Method (TCM)

Definition: The Travel Cost Method is a revealed preference approach used to estimate the economic value of recreational sites by observing the costs individuals incur to visit the site.

Key Features:

- Relies on travel expenses (e.g., transportation, lodging, time) as a proxy for the value individuals place on the site.
- Assumes that the number of trips to a site is inversely related to the travel cost.
- Estimates demand curves for recreational visits to derive consumer surplus.

Example of Travel Cost Method

Scenario: Valuing a National Park

A study aims to estimate the recreational value of a national park by analyzing travel costs.

Steps:

- **Data Collection:** Survey visitors on their travel expenses, including fuel, lodging, and time costs.
- **Demand Curve:** Estimate how the number of trips decreases as travel costs increase.
- **Consumer Surplus:** Use the demand curve to calculate the economic value visitors derive from the park.

Result: If the total consumer surplus is \$5 million, this represents the recreational value of the park to its visitors.

Hedonic Pricing Method (HPM)

Definition: The Hedonic Pricing Method estimates the value of non-market goods by analyzing how their characteristics affect the price of related market goods.

Key Features:

- Relates variations in prices (e.g., housing) to specific attributes (e.g., proximity to parks, air quality).
- Requires detailed data on prices and relevant characteristics.
- Captures use values but not non-use values.

Applications:

- Commonly used to value environmental amenities or disamenities, such as green spaces or pollution.
- Provides monetary estimates for cost-benefit analyses.

Example of Hedonic Pricing Method

Scenario: Valuing Clean Air Through Housing Prices

A study examines how air quality impacts housing prices in a metropolitan area.

Steps:

- **Data Collection:** Compile housing prices and attributes (e.g., size, location, air quality index).
- **Regression Analysis:** Estimate how changes in air quality affect housing prices while controlling for other factors.
- **Value Estimation:** Derive the implicit price of clean air from the regression coefficients.

Result: A 10-point improvement in the air quality index increases housing prices by 5%, suggesting significant value placed on clean air.

Hedonic Pricing Regression Model

Regression Equation:

$$P_i = \beta_0 + \beta_1 \text{Size}_i + \beta_2 \text{Bedrooms}_i + \beta_3 \text{Bathrooms}_i + \beta_4 \text{AirQuality}_i + \epsilon_i$$

Where:

- P_i: Price of house i
- β_0: Intercept term
- $\beta_1, \beta_2, \ldots, \beta_5$: Coefficients for each attribute
- AirQuality_i: Air quality index near house i
- ϵ_i: Error term capturing unobserved factors

Interpretation:

- A positive β_4: Better air quality increases house prices.
- A negative β_5: Proximity to parks increases house prices.

Interpreting Hedonic Pricing Regression Results

Variable	Coefficient	Standardized Coefficient	Std. Error	*t*-Statistic	*p*-value	VIF
(Constant)	-7.537	-	3.862	-1.952	0.051	-
Size	16.288	0,563	0.761	21.413	0.000	3.183
Bathrooms	14.242	0,130	1.806	7.885	0.000	1.052
EntireUnit	14.957	0,143	1.692	8.839	0.000	2.840
AmenitiesIndex	2.401	0,058	0.434	5.529	0.000	1.308
RentalPolicy	0.925	0,020	0.416	2.223	0.026	1.199
Location	-3.097	-0,059	0.516	-5.998	0.000	1.550
HostVerified	0.038	0,001	0.843	0.045	0.964	1.058
Superhost	5.308	0,047	1.129	4.701	0.000	1.471
HostExperience	-0.002	-0,002	0.005	-0.338	0.736	1.024
ReviewValence_PCA	0.165	0,003	0.495	0.334	0.739	1.181
ReviewVolume	-0.047	-0,068	0.008	-5.815	0.000	1.799
Valence_*x*_Volume	0.043	0,038	0.013	3.390	0.001	1.715
CompetitionIntensity	0.004	0,023	0.002	2.617	0.009	1.433
CompetitionPrice	0.108	0,032	0.050	2.177	0.030	1.494
R-squared	0.596					
Adjusted *R*-squared	0.596					
F-statistic	651.277					
Prob(*F*-statistic)	0.000					

Figure 7: Welcome to Zillow.

Alternate Pricing Methods

Definition: Alternate pricing methods are techniques used to value non-market goods and services by leveraging market and behavioral data, without relying directly on stated or revealed preferences.

Common Approaches:

- **Benefit Transfer:** Adapts valuation estimates from existing studies to a new context or location.
- **Replacement Cost Method:** Estimates the value of an ecosystem service based on the cost of replacing it with human-made alternatives.
- **Avoided Cost Method:** Values goods based on the costs avoided due to the existence or functioning of an environmental resource.
- **Production Function Approach:** Assesses how changes in ecosystem services impact economic productivity.

Indirect Market Methods

Definition: Indirect market methods estimate the value of non-market goods and services by observing behavior in related markets or activities.

Key Features:

- Based on actual behavior, not hypothetical scenarios.
- Captures values indirectly associated with market transactions.
- Relies on market linkages to infer values.

Common Methods:

- **Travel Cost Method:** Uses travel expenses to value recreational sites.
- **Hedonic Pricing Method:** Relates property or wage variations to environmental attributes.
- **Damage Cost Avoided:** Values environmental benefits based on the costs avoided (e.g., health costs avoided due to cleaner air).

The Trade-Off Method

Definition: The trade-off method estimates the value of non-market goods or services by examining how individuals make trade-offs between these goods and market goods, services, or other measurable attributes.

Key Features:

- Relies on individuals' implicit or explicit decisions to balance competing preferences.
- Typically uses survey techniques or observed behaviors to identify trade-offs.
- Captures both use and non-use values depending on the context.

Production Function Method

Definition: The production function method estimates the value of an environmental good or service by analyzing its contribution to economic production processes.

Key Features:

- Links changes in environmental quality to changes in productivity or output.
- Relies on well-defined relationships between inputs (including environmental goods) and outputs.
- Captures use values derived from ecosystem services (e.g., water for irrigation, pollination for crops).

Regression to Estimate Production Function

Regression Model:

$$Y_i = \alpha + \beta_1 \text{Labor}_i + \beta_2 \text{Capital}_i + \beta_3 \text{EnvironmentalGood}_i + \epsilon_i$$

Where:

- Y_i: Output or productivity for producer i.
- α: Intercept term.
- $\beta_1, \beta_2, \beta_3$: Coefficients representing the marginal contributions of each input to production.
- $\text{EnvironmentalGood}_i$: Quantity or quality of the environmental good (e.g., clean water, pollination services).
- ϵ_i: Error term capturing unobserved factors.

Estimation Objective:

- The coefficient β_3 reflects the marginal productivity of the environmental good, providing its implicit economic value.

Damage Function Approach

Definition: The damage function approach estimates the economic value of environmental degradation by quantifying its impact on outcomes such as health, productivity, or infrastructure.

Key Features:

- Relates environmental changes (e.g., pollution, climate impacts) to measurable damages or losses.
- Captures the costs of adverse effects, including direct and indirect impacts.
- Often relies on scientific and economic models to establish causal relationships.

Regression to Estimate Damage Function

Regression Model:

$$D_i = \alpha + \beta_1 \text{EnvironmentalVariable}_i + \beta_2 \text{PopulationExposed}_i + \beta_3 \text{EconomicActiv}$$

Where:

- D_i: Damage (e.g., health costs, productivity losses) for area or sector i.
- α: Intercept term.
- $\beta_1, \beta_2, \beta_3$: Coefficients representing the marginal effects of each variable.
- $\text{EnvironmentalVariable}_i$: Measure of environmental degradation (e.g., air pollution levels, temperature change).
- $\text{PopulationExposed}_i$: Number of individuals or extent of exposure in area i.
- $\text{EconomicActivity}_i$: Level of economic activity affected in area i (e.g., crop value, industrial output).
- ϵ_i: Error term capturing unobserved factors.

Avoided Cost Method

Definition: The avoided cost method estimates the economic value of environmental goods or services based on the costs that are avoided due to their existence or functioning.

Key Features:

- Measures benefits indirectly by estimating savings from avoiding damages or alternative costs.
- Commonly used for ecosystem services that mitigate risks or reduce infrastructure needs.
- Does not capture non-use values, focusing only on avoided expenses.

Applications:

- Valuing flood control benefits provided by wetlands.
- Estimating the cost savings from natural water filtration by forests.
- Calculating health cost savings from improved air quality.

Pitfalls of Revealed Preference Methods

Challenges and Limitations:

- **Market Dependency:**
  - Revealed preference methods require observable market behaviors.
  - Cannot capture non-use values (e.g., existence or bequest values).
- **Limited Scope:**
  - Focuses on use values, ignoring broader societal or ecological benefits.
  - Assumes rational behavior in markets, which may not always hold.
- **Complexity of Attribution:**
  - Difficult to isolate the effect of a single environmental factor in market decisions.
  - Confounding factors can obscure true relationships (e.g., income, preferences).
- **Data Limitations:**
  - Requires high-quality, granular data on market transactions and attributes.
  - May not be feasible for all environmental goods or services.

What Are Stated Preference Methods?

Definition: Stated Preference (SP) methods are survey-based approaches used to estimate the economic value of non-market goods and services by directly asking individuals about their preferences.

Key Features:

- Directly measures individuals' willingness to pay (WTP) or willingness to accept (WTA) compensation for changes in non-market goods or services.
- Hypothetical scenarios are presented, eliciting preferences in a controlled manner.
- Captures both use values (e.g., recreational use) and non-use values (e.g., existence or bequest values).

Contingent Valuation Method (CVM)

Definition: Contingent Valuation Method (CVM) is a survey-based economic technique used to estimate the value that individuals place on non-market goods or services, such as environmental resources or public goods.

Key Features:

- Relies on hypothetical scenarios to elicit individuals' willingness to pay (WTP) or willingness to accept (WTA).
- Commonly used for valuing environmental goods (e.g., clean air, biodiversity).
- Suitable for both use and non-use values.

Example: Valuing Clean Water Access

Scenario: A community is asked their willingness to pay for a project that ensures clean water access for all households. The project will cost $10 million and improve water quality in the local river.

Survey Question: "Would you be willing to pay $X per year as an additional tax to fund the clean water project?"

- Respondents are given different values of $X (e.g., $10, $50, $100).
- Responses are analyzed to estimate average WTP and total project value.

Results: If the average WTP is $50 and the population is 200,000, the total WTP for the project is estimated at $10 million, matching the project cost.

Contingent Valuation Steps

1. Identify a sample of respondents
2. Ask respondents about their value of the good
3. Use responses to estimate willingness to pay
4. Extrapolate responses to entire population

Introduction to Non-Market Valuation with Discrete Choice Modeling

- **Discrete Choice Modeling (DCM):** DCM is a method used to estimate individual preferences by presenting choices among hypothetical alternatives with varying attributes.
- **Application:** Commonly applied in environmental economics, transportation, and public health to value non-market goods and services.
- **Survey Structure:** Respondents are asked to choose between two or more options with different levels of attributes (e.g., cost, quality, environmental impact).
- **Objective:** To infer the trade-offs people make and to estimate their willingness to pay (WTP) for changes in attributes of non-market goods.

Mathematical Formulation of Discrete Choice Modeling

- **Utility Framework:** Each respondent i is assumed to choose the alternative that maximizes their utility:

$$U_{ij} = V_{ij} + \epsilon_{ij}$$

where U_{ij} is the utility from alternative j, V_{ij} is the observable (deterministic) component of utility, and ϵ_{ij} is the unobserved (random) component.

- **Choice Probability:** The probability that respondent i chooses alternative j is given by:

$$P_{ij} = \Pr(U_{ij} > U_{ik}) \quad \forall k \neq j$$

Modelling Continued

- **Logit Model (Example):** In the case of a multinomial logit model, the choice probability is:

$$P_{ij} = \frac{\exp(V_{ij})}{\sum_k \exp(V_{ik})}$$

- **Willingness to Pay (WTP):** WTP for an attribute x is calculated as the ratio of the attribute's coefficient to the cost coefficient:

$$\text{WTP}_x = -\frac{\beta_x}{\beta_{\text{cost}}}$$

Interpretation Discrete Choice Modelling

- **Interpretation:** This model provides estimates of how changes in non-market attributes affect choice probability, allowing us to quantify values for non-market goods.

Conclusion

Discrete choice modeling enables estimation of non-market values, informing policy decisions by quantifying the benefits of goods and services not traded in conventional markets.

Discrete Choice Modeling Example

Scenario: A study evaluates individuals' preferences for beach visits based on attributes like water quality, distance, and cost of travel.

Regression Model:

$$U_{ij} = \beta_1 \text{WaterQuality}_j + \beta_2 \text{Distance}_{ij} + \beta_3 \text{Cost}_{ij} + \epsilon_{ij}$$

Where:

- U_{ij}: Utility individual i derives from choosing beach j.
- $\beta_1, \beta_2, \beta_3$: Coefficients indicating the relative importance of each attribute.
- WaterQuality_j: Quality of water at beach j.
- Distance_{ij}: Distance traveled by individual i to reach beach j.
- Cost_{ij}: Travel cost incurred by individual i to visit beach j.
- ϵ_{ij}: Error term capturing unobserved factors.

Interpreting Results of Estimation

Interpretation:

- A positive β_1: Higher water quality increases the probability of visiting a beach.
- Negative β_2, β_3: Greater distance and cost reduce the probability of visitation.

Interpreting Results of Estimation

```
Call:
glm(formula = c_sclfsat1 ~ AgeGroups + sex + c_employ + c_finnow +
    qualoc_dv + c_locserb + HHsize + c_grimyn + c_locsere, family = binomial(link = logit),
    data = projectdata)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.4099  -0.8590  -0.7911   1.4070   2.0220

Coefficients:
               Estimate Std. Error z value Pr(>|z|)
(Intercept)     0.38489    0.07993   4.816 1.47e-06 ***
AgeGroups40-49  0.14676    0.03429   4.280 1.87e-05 ***
AgeGroups50-59  0.19747    0.03633   5.435 5.47e-08 ***
AgeGroups60-69 -0.15549    0.04271  -3.641 0.000272 ***
AgeGroups70-79 -0.31306    0.05083  -6.158 7.35e-10 ***
AgeGroups80-89 -0.43082    0.06625  -6.503 7.87e-11 ***
AgeGroups90+   -1.07924    0.19737  -5.468 4.55e-08 ***
sex1           -0.03945    0.02306  -1.711 0.087107 .
c_employ1      -0.26003    0.02907  -8.946  < 2e-16 ***
c_finnow1      -0.40050    0.03486 -11.489  < 2e-16 ***
qualoc_dv1     -0.04937    0.02653  -1.861 0.062813 .
c_locserb1     -0.21265    0.05674  -3.748 0.000178 ***
HHsize2 People -0.14395    0.03316  -4.341 1.42e-05 ***
HHsize3 People -0.17845    0.04048  -4.408 1.04e-05 ***
HHsize4 People -0.19193    0.04193  -4.577 4.71e-06 ***
HHsize4+       -0.40321    0.04818  -8.369  < 2e-16 ***
c_grimyn1      -0.13947    0.03518  -3.965 7.35e-05 ***
c_locsere1     -0.19495    0.02995  -6.509 7.56e-11 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 45813  on 37009  degrees of freedom
Residual deviance: 45221  on 36992  degrees of freedom
  (8893 observations deleted due to missingness)
AIC: 45257
```

Figure 8: Logistic Regression in R

Pitfalls of Stated Preference Methods

Common Challenges:

- **Hypothetical Bias:** Responses may not reflect real-world behavior since scenarios are hypothetical.
- **Strategic Bias:** Respondents may intentionally overstate or understate their WTP/WTA to influence outcomes.
- **Design Bias:** Poorly designed surveys can lead to misleading results (e.g., leading questions or unrealistic scenarios).

Other Issues:

- **Starting Point Bias:** Initial values in surveys can anchor responses.
- **Information Bias:** Respondents may lack sufficient knowledge to provide informed answers.
- **Complexity:** Detailed scenarios or multiple attributes may overwhelm respondents.

Thank You So Much!

List of References