

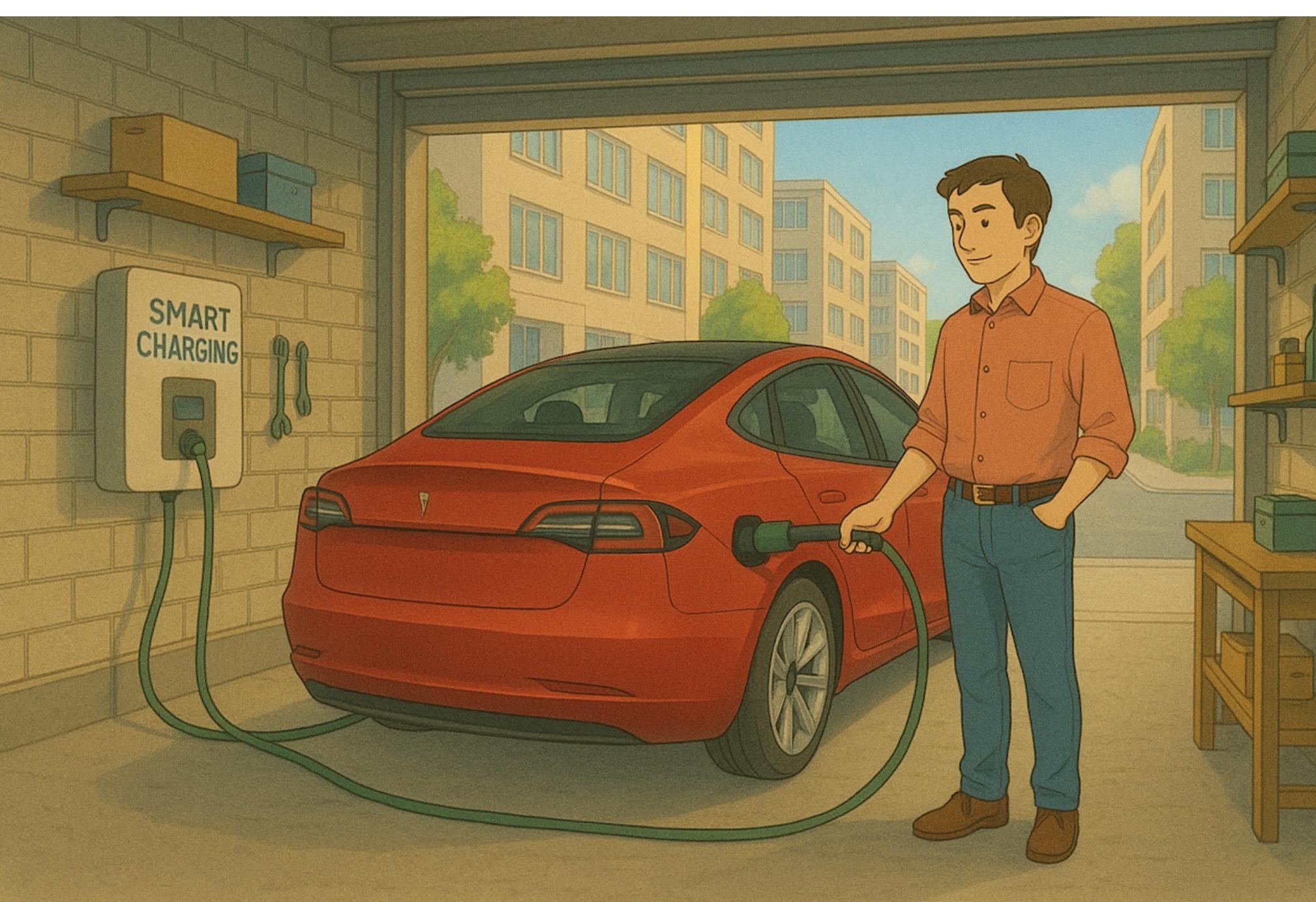
Electric Vehicle Owner Preferences for Smart Charging

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Introduction

- Unmanaged Battery Electric Vehicle (**BEV**) charging can increase costs and emissions.
- Managed charging can reduce costs and pollution. It can reduce peak loads to avoid overloading the power grid.
- Smart charging is a type of managed charging, which includes Supplier-Managed Charging (**SMC**), and Vehicle-to-Grid (**V2G**).



Research Questions

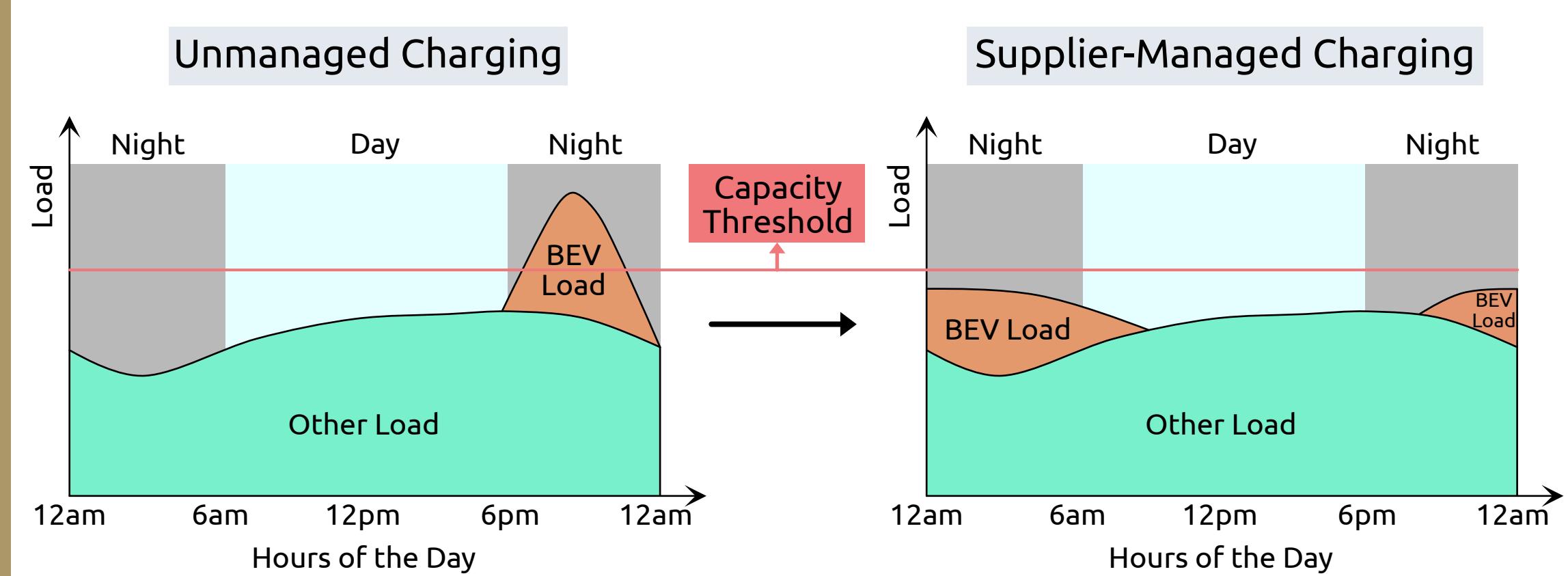
- 1. Sensitivity:** How do changes in smart charging program features influence BEV owners' willingness to opt in?
- 2. Market Share:** Under what conditions will BEV owners be more willing to opt in to smart charging programs?

Method

- 1. Conjoint survey** to collect BEV owners' willingness. Obtained **1,356** results from Meta and Dynata.
- 2. Multinomial logit model (MNL)** for utility simulations in enrollment sensitivity, equivalency study, and scenario analysis.

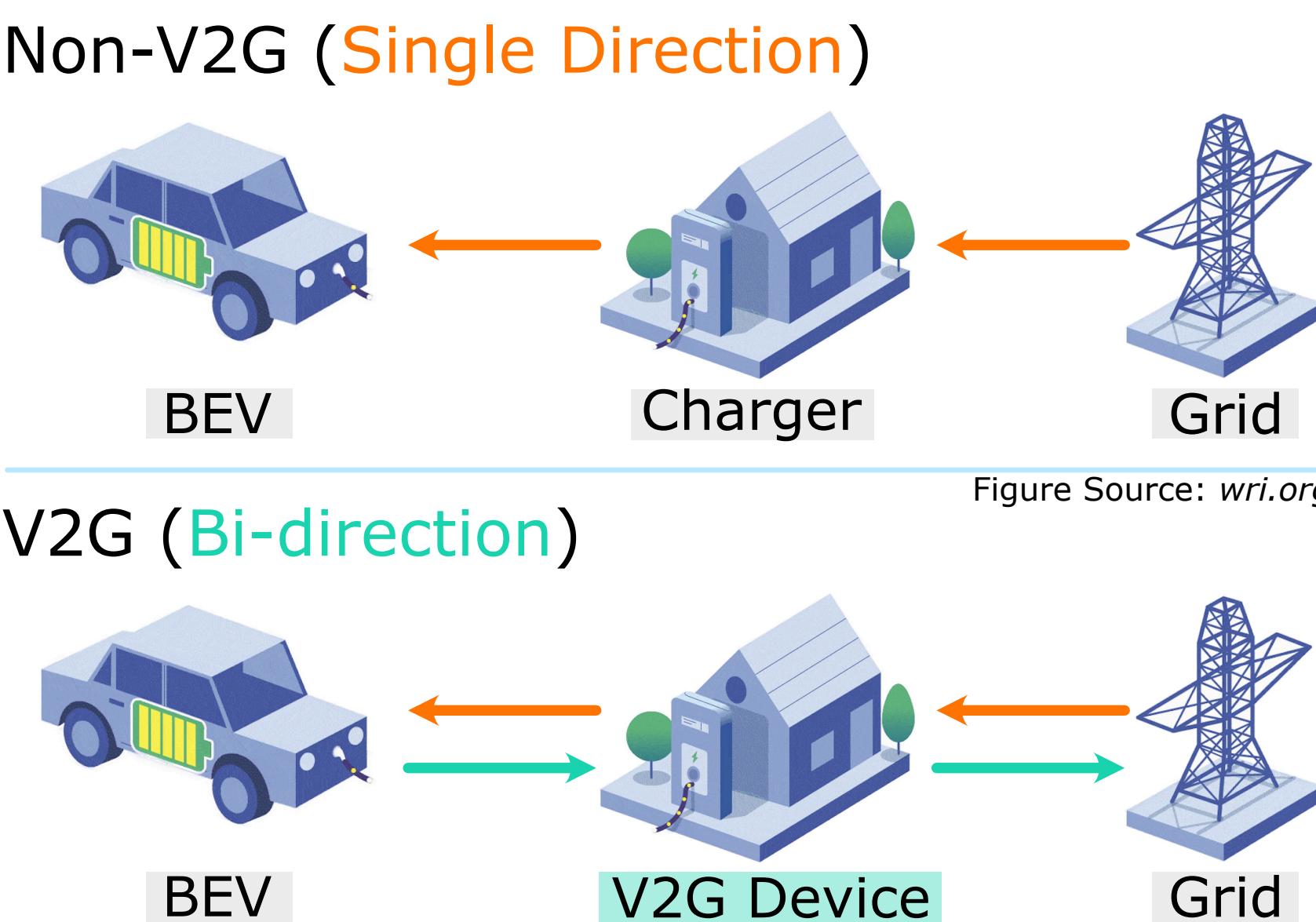
Smart Charging Programs

Supplier-Managed Charging (SMC)



Supplier-managed charging avoids peak loads by shifting BEV charging to times with less peak demand.

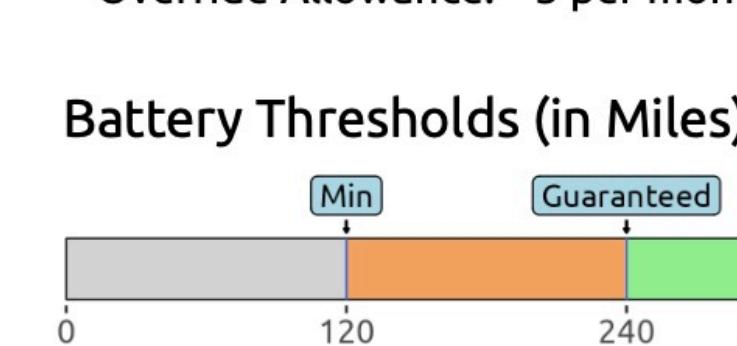
Vehicle-to-Grid (V2G)



In a V2G event, BEVs can charge the grid when necessary. BEVs are charged back eventually. Owners earn money.

Conjoint Survey & Logit Model

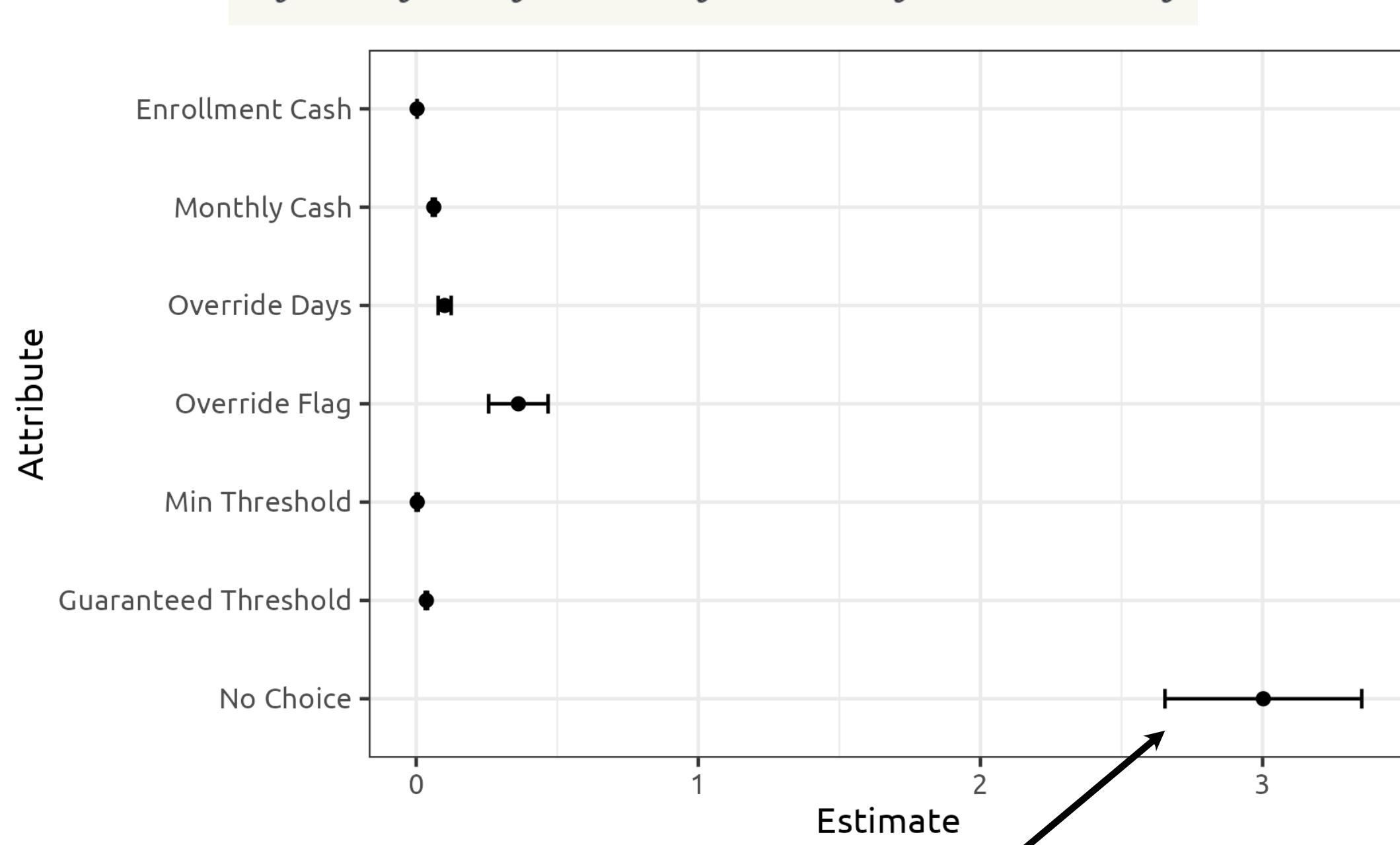
Survey Question

Option 1	Option 2	Option 3
Enrollment Cash: \$50 Monthly Cash: \$2 Override Allowance: 0 per month	Enrollment Cash: \$300 Monthly Cash: \$20 Override Allowance: 5 per month	Battery Thresholds (in Miles):  
Not Interested		

- Conjoint questions provide different **sets** of options.
- If you choose one option, you choose the whole set.
- In short, conjoint is about forcing people to make trade-offs.

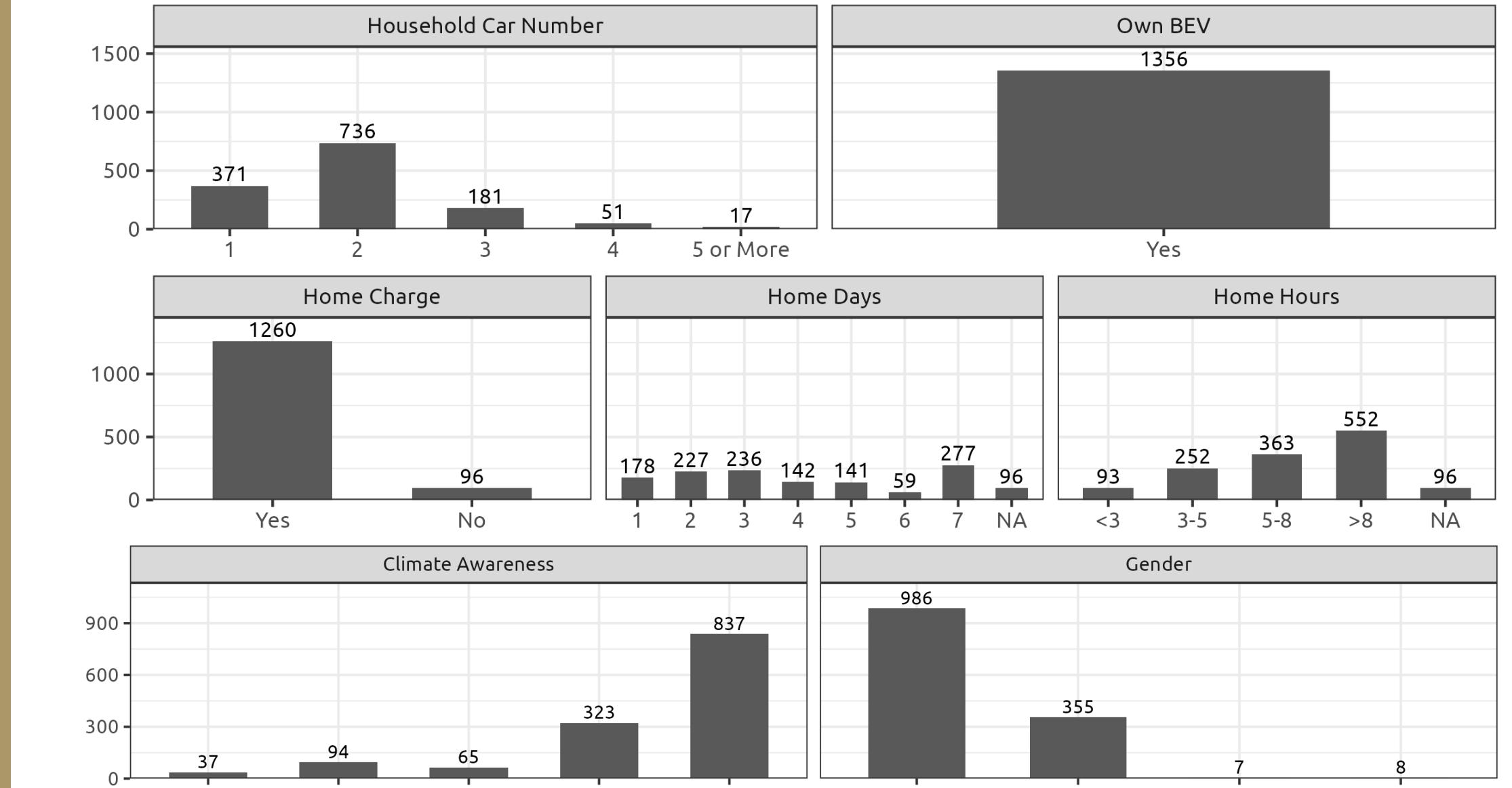
Logit Model

$$\hat{u}_j = v_j + \tilde{\epsilon}_j = \beta_1 x_{j1} + \beta_2 x_{j2} + \dots + \tilde{\epsilon}_j$$



Without compensation, users will not participate.

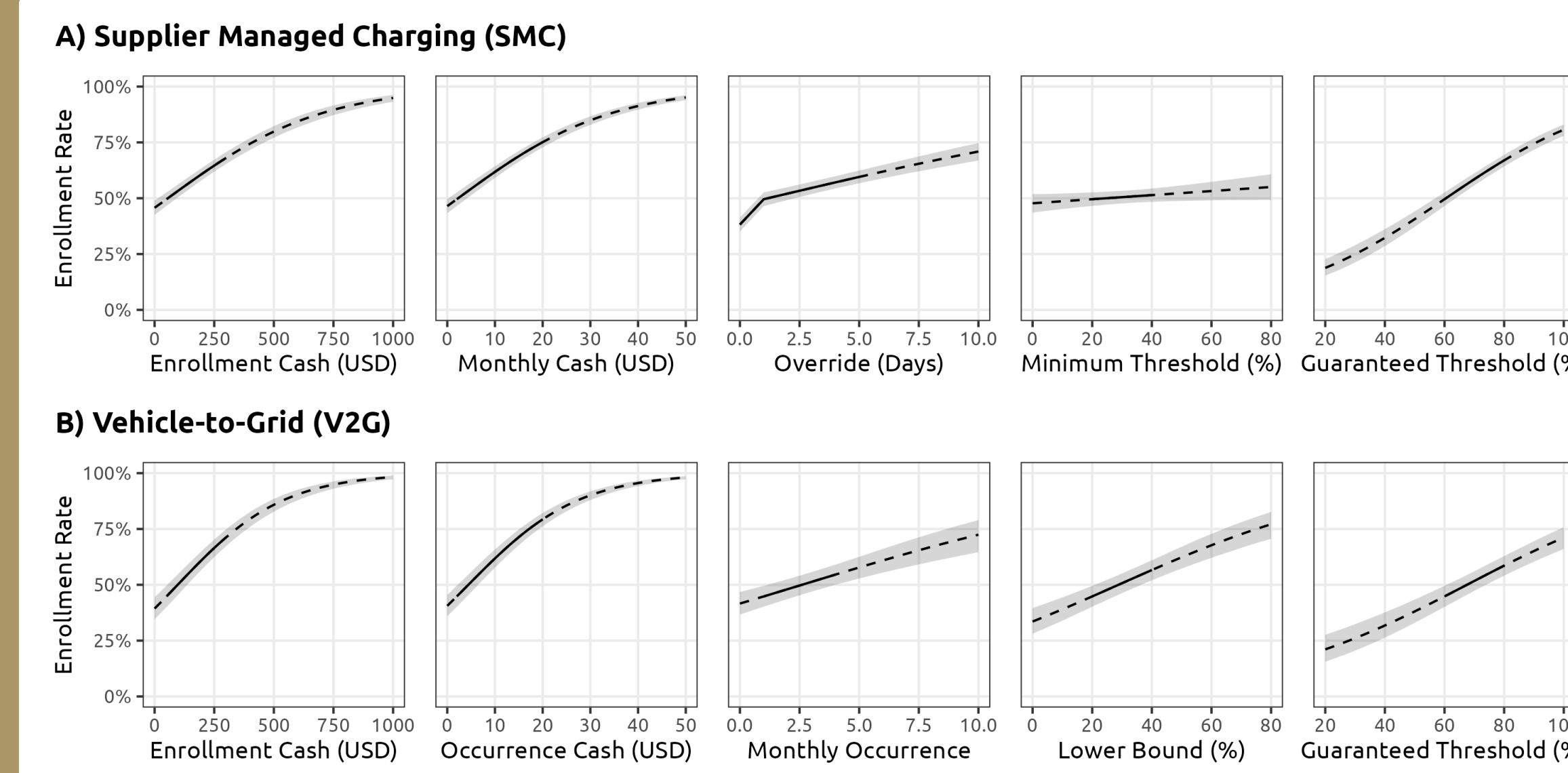
Demographic Results



- We have **100% BEV ownership**.
- Most families have at least **2** cars.
- Most owners charge **at home** for more than **8** hours.
- Most owners care of climate very much.
- Most owners are **male**.

Analysis

Enrollment Sensitivity



- Steeper slope indicates higher sensitivity.
- Diminishing returns exist, but solid parts (directly from results) are basically linear.

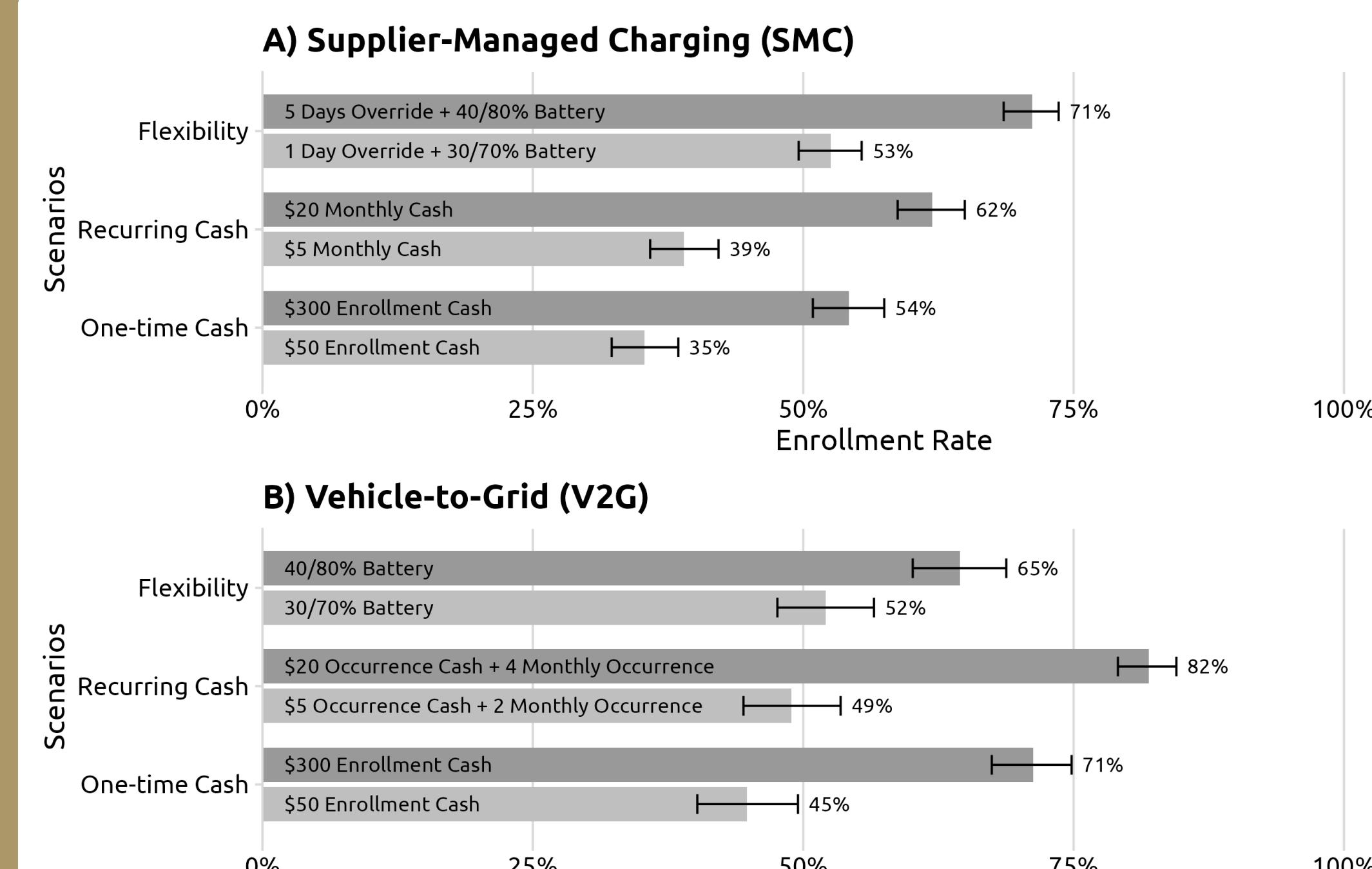
Equivalency of 5% Increase

SMC

Attribute	Equivalence Value	Unit
Enrollment Cash	64.7	\$
Monthly Cash	3.2	\$
Override Days	2.0	Days
Minimum Threshold	54.8	%
Guaranteed Threshold	5.5	%

- For SMC, guaranteed threshold is highly important, as is recurring incentives.
- For V2G, both thresholds matter, as is recurring incentives.

Scenario Analysis



In general, flexibility is more significant in SMC, while receiving payments is more significant for V2G.

