Advanced Microeconometrics: Project 3

1 Introduction

Using a dataset with the 40 most sold cars in five countries in the period 1970-1999 we examine the strength of the home bias, which is the preference for domestic products over foreign products. We will do this by using a conditional logit. We will also analyze how it affects the own-price semi-elasticities of demand. We find evidence of home bias in our dataset.

2 Data

The data set contains five countries; four countries have domestic car manufacturing: France, Germany, Italy, and the UK, and one country that does not have any domestic car manufacturing in the observed period: Belgium. In the data set provided, there is for each of the 5 countries the 40 most sold cars in each year in 1970-1999. The number of observations therefore is:

$$Obs = years \cdot countries \cdot cars = 30 \cdot 5 \cdot 40 = 6000$$

The cars that are most sold differ from country to country and year to year. In the data set, there are different variables describing different characteristics of the car. The chosen characteristics of the car included in our model are price relative to per capita income, brand code, weight (in kg), cylinder value of displacement, domestic car dummy, horsepower, and a measure of the car's fuel efficiency. We have included these variables, as we believe they could be important for the demand.

The markets, i, are defined as country-year pairs, meaning there are 150 markets. The types of cars, j, is the number of alternatives included in the analysis, which in this case is 40. Due to this ij-structure the conditional logit is appropriate. Due to the choice of model, which we will elaborate on in the next section, we will only be able to work with car characteristics that differ both across markets and car alternatives.

3 Theory

We want to model the effect of different car-specific characteristics on car brands' market shares across countries, based on an underlying utility model of household preferences over cars. Using a conditional logit model, we can estimate common coefficients of car characteristics, including the home market effect. In the following sections, we will go through the model, the estimation method, and how we finally arrive at the partial effects and price elasticities.

3.1 Conditional logit

The conditional logit model works from an underlying random utility model of identical households' utility of alternative car choices with different characteristics.

$$u_{ijh} = x_{ij}\beta_o + \epsilon_{ijh}$$

The model assumes a common vector of coefficients, $\beta_{\mathbf{0}}$ across cars, describing the relation between the car characteristic and the household's potential utility.[1] As such the model does not allow for characteristics to have different levels of utility contribution in different alternatives. ϵ_{ijh} is an error term representing the unobservable element of the household's preferences over cars. The error term is assumed to be extreme value independently distributed over markets, cars, and households. The household chooses the car from among all the alternatives that produce the largest utility for them.

McFadden (1974) showed that assuming the extreme value distribution of the error term, the response probabilities can be expressed given the conditional logit model:

$$P(y_i = j|\mathbf{x}_i) = \frac{exp(\mathbf{x}_{ij}\boldsymbol{\beta})}{\sum_{h=0}^{J} exp(\mathbf{x}_{ih}\boldsymbol{\beta})}, \quad j = 0, ..., J \tag{1}$$

From the way we modeled households as identical, with independently distributed ϵ, the market demand is the sum of household demands, and as such the market share can be understood as the average household response probabilities, as they are coincidentally expressed in equation 1.

[1] Wooldridge (2010), page 647.

Besides the assumptions explicitly mentioned in the model setup, the previously mentioned assumption of i.i.d. error terms implies the assumption of the independence of irrelevant alternatives (IIA). IIA assumes that the ratio of market shares, the probabilities from 1, between two cars does not depend on other alternative cars. This assumption can be unviable if the model includes similar alternatives that are likely to affect the choice of each other.

Specific to the conditional logit model is the requirement of the explanatory variable to be differentiated across both markets, i, and choices, j. Variables that only vary across markets but that are the same across cars, as an example; the VAT rate, would not have their β values identified, and have to be left out of the model.

3.2 Maximum likelihood estimation

We estimate the model using maximum likelihood estimation (MLE), by calculating each market's loglikelihood contribution.

$$\ell_i(\boldsymbol{\beta}) = \sum_{j=1}^{J} y_{ij} \ln s_j(\mathbf{x}_i, \boldsymbol{\beta})$$

Where y_{ij} is the market share of car j in market i. The estimator, $\hat{\beta}$, maximizes the average of the log-likelihood contributions over the N markets:

$$(\hat{\boldsymbol{\beta}}) \in \arg\max_{\boldsymbol{\beta} \in \mathbb{R}^K} \frac{1}{N} \sum_{i=1}^{N} \ell_i(\boldsymbol{\beta})$$

The assumptions needed to obtain a consistent and asymptotically normal (A.N.) estimator are presented in box 1.

Box 1: MLE assumptions

Theorem	Assumption	Consistency	A.N.
12.2 (a)	Compactness	X	
12.2 (b)	$\ell(y_i, X_i, \beta)$ is a continuous function of β	X	
12.2 (c)	β_0 uniquely minimizes $E[-\ell_i(y_i, X_i, \beta]$	X	
12.3 (a)	β_0 is an interior solution to R^P	X	X
12.3 (b)	$\ell(y_i, X_i, \beta)$ is continuous and twice differentiable	X	X

Source: Wooldridge (2010), page 404-407

3.3 Partial effects

We calculate the own price partial effects in the following way:

$$PE_{ij}(\log \mathbf{p}) = \frac{\partial s_j^*}{\partial \log p_{ij}}(\mathbf{p}) = \beta_{o,k} s_j(\mathbf{p}, \boldsymbol{\theta}_0)[1 - s_j(\mathbf{p}, \boldsymbol{\theta}_0] \tag{2}$$

Where s is the market share and p is the price. Be aware that we have used log prices in this assignment and, therefore, also in the calculation of the partial effects.

3.4 Price elasticity

The price elasticities determine the sensitivity to the price of a good. A lower numerical elasticity implies a product that has a more price-insensitive demand.

We have calculated the own-price elasticities in demand to see whether there is a home bias. As we use log prices, we use semi elasticities which can be defined as follows:

$$\frac{\partial s_j}{\partial p_{ij}} \frac{p_{ij}}{s_j} = \frac{\partial s_j}{\partial \log p_{ij}} \frac{1}{s_j}$$

In this expression, we insert the partial effects expressed as in equation 2:

$$\frac{\partial s}{\partial p} \frac{p}{s} = \beta_{o,k} s_j (1 - s_j) \frac{1}{s_j} = \beta_{o,k}(1 - s_j)$$

4 Results

We have investigated whether there is a home bias in the market for cars - whether people prefer buying domestic cars over foreign cars.

We begin by exploring the relationship between the market share and the two variables $\log(price)$ and *home*. The variable *home* indicates whether the car is domestic in the market. The results are presented in Table 1. The parameter estimate of the logarithm to the price is significant and negative, which implies that a higher price will give a lower market share, all else being equal. The *home*-variable is positive and highly significant. This implies a preference for a domestic car, such that domestic cars have a higher market share.

Next, we turn to calculating the semi-elasticities reported in Table 2. We see a numerically lower elasticity for domestic cars than for foreign cars, which implies that foreign cars are more price-sensitive. This points in the direction of a home bias in the market for cars.

5 Discussion and conclusion

By modelling the households' choice of car from different car alternatives, using a conditional logit model, we have found that foreign cars have larger own-price elasticities than the home-car alternative. This result supports the theory of home bias, implying that households have a preference for buying domestic cars over foreign cars.

6 Output

Table 1: Estimation			
	theta	**se**	**t**
logp	-0.5145***	0.1301	-3.9550
home	1.3744***	0.0316	43.4428
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$			

Table 2: Elasticities	
Elasticity for "home" cars, ϵ_H	-0.4921
Elasticity for "foreign" cars, ϵ_F	-0.5061