# HW 2: Differentiated product markets
Logit Demand Estimation

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Industrial Organization
Econ 4376
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Warning: To successfully solve HW 2, you need to attend classes. For this HW, attendance on Thursday, February 9, Thursday, February 16 is crucial. In other words, you won't be able to solve this HW otherwise. If you have a laptop, bring it to class on these days.

Before developing a new model, auto manufacturers go through an extensive planning process to determine what new models are feasible and how profitable each might be. Key questions for the profit calculation are: What will the other manufacturers do, and how does that depend on what we do? How much demand will there be?

In this exercise you will investigate what type of car Tesla should produce next: an electric sedan or an electric SUV. Imagine you are in 2012 and you are advising Tesla. GM will also develop either an electric sedan or an electric SUV, but it is behind schedule and will wait to see what Tesla develops before deciding. The tree below represents this situation. Tesla decides first on what to do and then GM decides. Both firm can do two different things: produce a Sedan (this is indicated with a zero in the profit function) or produce an SUV (this is indicated with a one in the profit function). At the end of each branch you will see the possible profits of these outcomes. So for example, $\pi_T(0,0)$ indicates the profit for Tesla, if both Tesla and GM decided to produce a Sedan (the choice labeled with zero).
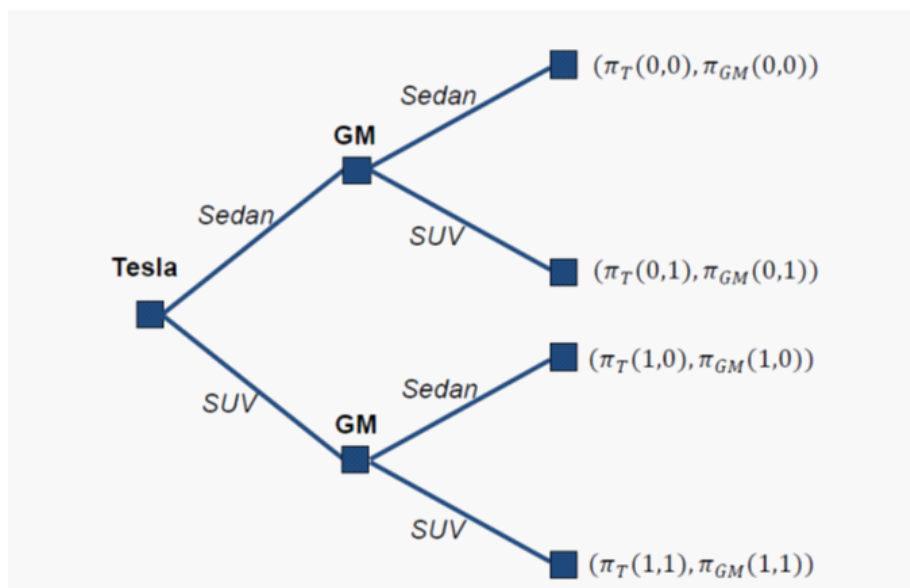
To advise Tesla on what to do, you will need to compute the four possible profits and decide which option is the best for Tesla.

Questions:

1. Write down the profit function for Tesla and for GM.

2. Write down your plan for quantifying the profit. I.e., write down the steps you are proposing to compute the profits.

For simplicity, assume that the prices are as in AutoData.csv. The engineers have also forecasted marginal costs. You need to predict sales (quantities sold) for models that don't exist yet. You need to use the logit model discussed in class. Assume that the utility from not buying a new car is zero, so $\delta_0 = 0$.

Based on the logit model, quantity sold is:

$$q_j = N s_j = N P_{ij} = N \frac{e^{\delta_j}}{1 + \sum_k e^{\delta_{k'}}}$$

where N is the number of consumers in the market and

$$\delta_j = \beta X_j + \xi_j$$

where X_j includes price, gallons per mile (GPM), weight, and horsepower (HP).

To get the four possible profits, you need to get N, β, X_j and ξ_j for new models. The X_j of the new models are given on the slides attached to this exercise. Assume that the market size (N) is 250 million.

3. Estimate the demand, i.e. estimate β's for each characteristic and the vector of ξ_j's.

4. Compute e^{δ_j}, s_j and π_j for all models, including the two new models. You need to do this four times, depending on what the new models are, i.e., where we end up on the graph above.

5.a. What is GM's car choice (sedan or SUV)? Explain your answer.

5.b. What is Tesla's car choice (sedan or SUV)? Explain your answer.

5.c. What is GM's profit? Explain your answer.

5.d. What is Tesla's profit? Explain your answer.