Memorandum

To: Carleton Faculty Member
From: Nick Leeke, Ziyang Gao, Bolu Johnson
Date: October 15, 2015
Re: Hybrid Car Question

The following memorandum aims to assist a Carleton College faculty member living in Minneapolis/St. Paul in deciding whether or not to purchase a hybrid vehicle (as opposed to a conventional model). According to our mode, expected parameters, and assuming that the buyer is considering **only personal net benefits, the faculty member should not purchase a hybrid vehicle.**

This recommendation is based on an analysis of the costs and benefits for two nearly identical vehicles. The only difference is the fact that one is a hybrid model and the other a conventional model—the two alternatives considered. This process in whole is subsequently explained in-depth. **Firstly, however, it is important to explain the factors that played into this analysis and the assumptions we made.**

- Stakeholders: We chose to limit the groups with standing to Carleton Faculty members (consumers) and the general society. These are the groups whose cost and benefits we are most concerned with
- Variables: The following variables were inputs into our model and final calculations: initial cost of the vehicle, horizon value of the vehicle as a percent of initial cost, cost of gasoline per gallon, miles driven per year, vehicle fuel economy, social cost of carbon, and discount rate
- Assumptions: Due to time constraints and in order to limit unnecessary variability, we made the following assumptions[1]
    1. The two vehicles used are the 2016 Toyota Camry LE and the 2016 Toyota Camry Hybrid. Costs will be paid in full upfront;
    2. The lifespan of both cars is 8 years, after which the cars will be sold for a horizon value;
    3. The owner drives between 14,000 and 16,000 miles/year—the average for individuals in their working ages;
    4. The discount rate stays constant over the next 8 years at 8%;
    5. The price of gas fluctuates uniformly between $2.00 and $4.00 over 8 years;
    6. The elasticity of demand for mileage is -0.7. This means that for every 0.7% decrease in gas price per mile, the consumer increases miles driven by 1%.

Using the aforementioned variables, <u>our model computes the net benefits of buying a Hybrid vehicle (total cost of Hybrid – total cost of Conventional)</u> **<u>in present value.</u>** After specifying alternatives, standing, and impact categories, the following calculations were performed in order to compute net benefits:

[1] These assumptions may be edited to specific parameters in the appended Excel file under the sheet "Variables"

1. **Calculation of Consumer Surplus**: Change in Consumer Surplus (CS) tells how much monetary surplus the faculty member receives when driving a Hybrid as opposed to a Conventional car. This is a function of fuel efficiency, gas price, miles driven, and demand elasticity. Change in CS was calculated for the first year and discounted accordingly over the lifespan of the project;
2. **Calculation of Difference in Resale Values**: Hybrid cars have a higher resale value than conventional cars in terms of percentage of original cost. The difference in these values adds to benefits accrued by consumers;
3. **Calculation of Difference in Original Prices**: Hybrid vehicles are generally more expensive than their conventional counterpart. Thus, the overall benefits of a hybrid must outweigh the difference in original costs in order for the purchase to be reasonable.

All values were discounted appropriately over the 8-year lifespan using an adjustable discount rate set at 8%. We found the following equation for Net Benefits:

Equation 1

Net Benefits =
Consumer Surplus + Difference in Resale Values - Difference in Original Costs

Because our model assumed that gas prices are uniformly distributed between $2.00 and $4.00 and miles driven/year between 14,000 and 16,000, we performed a sensitivity analysis in order to test the model's dependence on this variable. We held all values constant and calculated Net Benefits based on 1000 random values for gas prices. This process can be seen under the "Monte Carlo Simulation" tabs in Excel. Here is what we found: **based on Equation 1 and considering the said assumptions, the net benefits of buying a Hybrid are negative 61% of the time.**

Over an 8-year lifespan, however, a conventional car emits considerably more carbon than a hybrid so we chose to consider this 'social cost' when computing net benefits. This yields the following equation:

Equation 2

Net Benefits =
Consumer Surplus + Difference in Resale Values - Difference in Original Costs + Difference in Social Costs of Carbon

Using this equation and performing the same sensitivity analysis, we found that the net benefits of buying a Hybrid are positive 100% of the time. **This means if the faculty member wishes to consider both his net benefits and the external benefits to society, we recommend purchasing the hybrid car.** These trends are shown in the graph below

In conclusion, in order to choose between the two alternative choices, the faculty members must decide whether or not they are willing to take social impacts into consideration. When not considering social (external) impacts, our model shows that purchasing a hybrid vehicle would not make economic sense as the benefits would not

outweigh the costs. When one does consider social impacts, the hybrid vehicle will always benefits you more compared to the conventional.If there are additional questions, we are pleased to address these concerns and conduct further analysis.