MBA Teaching Note 08-02
Net Present Value Analysis of the Purchase of a Hybrid Automobile[1]

In this day and age of high energy prices and a desire to be more environmentally friendly, the automobile industry has presented us with some alternative vehicles in the form of "hybrids" that could save significant amounts of energy. But hybrids come with a higher price tag. The additional savings in fuel may or may not be balanced by the higher cost. Net present value analysis is ideally suited to determine whether a hybrid vehicle is worth the additional cost.

Purchasing and operating a car for personal use is strictly a matter of cost, with no revenues except from the sale of the vehicle. Even if the car is intended to be used for business purposes, it is likely that neither would generate more revenue than the other.[2] Thus, an NPV analysis can focus on the initial outlay, the annual operating costs, the cost of fuel, and the salvage value. Based on research, I find that the expected operating costs of a hybrid and a standard car are about the same. Thus, we can ignore these costs since to include an equivalent amount for both vehicles would not affect the advantage one vehicle has over the other.

NPV Analysis of a Honda Civic

Probably, the most successful hybrid has been the Toyota Prius, but for comparison purposes, the Prius is not a good choice because there is no non-hybrid version of it. Another successful and very low mileage hybrid is the Honda Civic, which has been produced in a standard version since 1972.

An NPV analysis of purchasing a hybrid Civic versus a standard Civic can be done fairly easily, though in any NPV analysis, one has to make assumptions. I collected the following information in the summer of 2008, during which regular fuel was about $4 a gallon. A hybrid Civic gets about 40 city miles and 45 highway miles to a gallon and has a manufacturer's suggested retail price (MSRP) of $25,020. A standard Civic gets about 25 city miles and 36 highway miles to a gallon and has a MSRP of $16,480.

Now let's make some assumptions. Say you drive an average of 1,000 miles a month and will drive no more or less with either car. Half of your driving is in the city and half is on the highway. You plan to keep your car five years. We also assume based on used car sales data that after five years, you can sell the standard Civic for $8,988.45 and the hybrid Civic for $13,646.30. Shown below is a portion of a spreadsheet that illustrates how to compare these two cars. Note that there are 60 rows, each representing one month during the cars' lives.[3] The gasoline cost and mileage figures are held constant but can easily be changed. We see that at 1,000 miles of driving per month, the hybrid would use 23.61 gallons per month on average, while the standard Civic would use 33.89 gallons per month on average. For the hybrid, this figure is based on 500 miles at 40 miles a gallon (12.50 gallons) plus 500 miles at 45 miles a gallon (11.11 gallons). For the standard, this figure is based on 500 miles at 25 miles per gallon (20 gallons) plus 500 miles at 36 miles per gallon (13.89 gallons). The monthly cost of gasoline would, therefore, be $94.44 for the hybrid (23.61 x $4.00) and $135.56 (33.89 x $4.00) for the standard.

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[1]I appreciate the research assistance of Pratik Dhar in compiling this teaching note.

[2]If this analysis were being done for a vehicle to be used by a business, we would need to account for the tax deductibility of depreciation.

[3]I have chosen to do the analysis on a monthly basis, but the difference would not be much if you did it annually. One problem in using annual cash flows is that you have to assume an integer number of years that you will own the car. Of course, you could use weekly or even daily data, but little would be gained by doing so and the effort would be much greater.

The cash flows from use of the car are outflows for mileage, but there is an inflow during the last month in the form of its expected salvage value. As you can see, it is entered as a negative, meaning that it is a negative outflow, or an inflow.

I chose a discount rate of 4%, which I am treating as essentially equally to the risk-free rate. While there is a risk of gasoline price increases or varying miles, the principal advantage of the hybrid in terms of mileage is likely to be not very risky. With a spreadsheet, you can easily insert different gasoline prices or miles driven and see what happens. We'll do that later. In any case, the 4% annual rate is treated as a 4%/12 = 0.33% monthly rate.

Summing up the present values of the monthly cash flows consisting of fuel costs plus final salvage value, we see at the bottom that the hybrid has a present value of -$18,972 and the standard has a present value of -$16,479. As you can see, the hybrid saves about $2,200 in present value of fuel costs and has a greater salvage value, which has a present value difference of about $3,800. Of course, hybrids have not been around long, so the hybrid salvage estimate might be off somewhat.

The sum of these two figures must then be balanced against the greater initial cost of the hybrid. The hybrid costs $8,540 more. Thus, the NPV of the hybrid over the standard is a negative $2,493. Hence, the standard is preferable.

Of course, a lot of people use the payback method. As we discuss in this course, this is not the appropriate method, but let's see what it gives us. Typically cash flows are not discounted when using the payback method. The initial outlay differential is $8,540. The annual operating differential is easily found. The cost of fuel for the hybrid is $94.44 a month so for a year, this is $1,133.28. The cost of fuel for the standard is $135.56 a month, which for a year is $1,626.72. The difference is $493.44. Thus, in a year the payback method says the hybrid saves $493.44. After five years, the hybrid has recovered $493.44 x 5 = $2,467.20. In the fifth year, its salvage value advantage is $13,646.30 - $8,988.45 = $4,657.85. Thus, the hybrid has "recovered" $2,467.20 + $4,657.85 = $7,125.05. This does not equal the initial cost disadvantage of the hybrid. Hence, it is clear that the hybrid would have to be used for more than five years.

But of course, the problem with the payback method is that we have not discounted the cash flows, and we do not have a benchmark. If the hybrid recovers its initial outlay in six years, is this good? We do not know.

What Factors Can Make a Hybrid More Attractive?

What would make the hybrid favorable? What about a higher cost of gasoline? We could insert higher prices for gasoline until the advantage to the hybrid goes from negative to zero. You would see that for these inputs, it would require gasoline at somewhere between $8 and $9 a gallon.

Another more reasonable change, however, could make the hybrid worthwhile. Going back to the case of gasoline at $4 a gallon, how miles of driving would make the hybrid more attractive? It turns out that changing the monthly miles to between 2,100 and 2,200 would give the hybrid have the same effective cost as the standard. Thus, for someone driving say at least 26,000 miles a year, the hybrid would be a better deal. And of course, a hybrid would more likely become cost-effective for a business as it would have the additional tax deductibility of the higher cost of the hybrid.

Conclusions

You should not draw any general conclusions about the attractiveness of hybrids over standard cars from the analysis. There may be other features associated with one of these vehicles that are not equivalent on the other. In comparing cars, you need to make the two vehicles as similar as possible. In addition, the maintenance costs may not be the same. But these factors can easily be built into the analysis. Based on the analysis done here, the hybrid is not financially justified unless fuel is $8 to $9 a gallon or you drive 26,000 miles or more a year

(assuming $4 gas). Of course, a business that has a lot of mileage, such as a taxi or delivery service, might justifiably prefer a hybrid.

And, of course, you may simply feel better and more environmentally conscious if you buy a hybrid. We cannot incorporate this factor into an NPV analysis.

		Hybrid				**Standard**		
Month	Miles	Gallons of Gas	Cost of Gas	PV of Cash Flows		Gallons of Gas	Cost of Gas	PV of Cash Flows
1	1,000	23.61	$94.44	$94.13		33.89	$135.56	$135.11
2	1,000	23.61	$94.44	$93.82		33.89	$135.56	$134.66
3	1,000	23.61	$94.44	$93.51		33.89	$135.56	$134.21
4	1,000	23.61	$94.44	$93.20		33.89	$135.56	$133.76
5	1,000	23.61	$94.44	$92.89		33.89	$135.56	$133.32
6	1,000	23.61	$94.44	$92.58		33.89	$135.56	$132.88
7	1,000	23.61	$94.44	$92.27		33.89	$135.56	$132.43
8	1,000	23.61	$94.44	$91.96		33.89	$135.56	$131.99
9	1,000	23.61	$94.44	$91.66		33.89	$135.56	$131.56
10	1,000	23.61	$94.44	$91.35		33.89	$135.56	$131.12
11	1,000	23.61	$94.44	$91.05		33.89	$135.56	$130.68
12	1,000	23.61	$94.44	$90.75		33.89	$135.56	$130.25
13	1,000	23.61	$94.44	$90.45		33.89	$135.56	$129.82
14	1,000	23.61	$94.44	$90.15		33.89	$135.56	$129.39
15	1,000	23.61	$94.44	$89.85		33.89	$135.56	$128.96
16	1,000	23.61	$94.44	$89.55		33.89	$135.56	$128.53
17	1,000	23.61	$94.44	$89.25		33.89	$135.56	$128.10
18	1,000	23.61	$94.44	$88.95		33.89	$135.56	$127.67
19	1,000	23.61	$94.44	$88.66		33.89	$135.56	$127.25
20	1,000	23.61	$94.44	$88.36		33.89	$135.56	$126.83
21	1,000	23.61	$94.44	$88.07		33.89	$135.56	$126.41
22	1,000	23.61	$94.44	$87.78		33.89	$135.56	$125.99
23	1,000	23.61	$94.44	$87.49		33.89	$135.56	$125.57
24	1,000	23.61	$94.44	$87.19		33.89	$135.56	$125.15
25	1,000	23.61	$94.44	$86.91		33.89	$135.56	$124.73
26	1,000	23.61	$94.44	$86.62		33.89	$135.56	$124.32
27	1,000	23.61	$94.44	$86.33		33.89	$135.56	$123.91
28	1,000	23.61	$94.44	$86.04		33.89	$135.56	$123.50
29	1,000	23.61	$94.44	$85.76		33.89	$135.56	$123.09
30	1,000	23.61	$94.44	$85.47		33.89	$135.56	$122.68
31	1,000	23.61	$94.44	$85.19		33.89	$135.56	$122.27
32	1,000	23.61	$94.44	$84.90		33.89	$135.56	$121.86
33	1,000	23.61	$94.44	$84.62		33.89	$135.56	$121.46
34	1,000	23.61	$94.44	$84.34		33.89	$135.56	$121.05
35	1,000	23.61	$94.44	$84.06		33.89	$135.56	$120.65
36	1,000	23.61	$94.44	$83.78		33.89	$135.56	$120.25
37	1,000	23.61	$94.44	$83.50		33.89	$135.56	$119.85
38	1,000	23.61	$94.44	$83.23		33.89	$135.56	$119.45
39	1,000	23.61	$94.44	$82.95		33.89	$135.56	$119.06
40	1,000	23.61	$94.44	$82.67		33.89	$135.56	$118.66
41	1,000	23.61	$94.44	$82.40		33.89	$135.56	$118.27
42	1,000	23.61	$94.44	$82.13		33.89	$135.56	$117.87
43	1,000	23.61	$94.44	$81.85		33.89	$135.56	$117.48
44	1,000	23.61	$94.44	$81.58		33.89	$135.56	$117.09
45	1,000	23.61	$94.44	$81.31		33.89	$135.56	$116.70
46	1,000	23.61	$94.44	$81.04		33.89	$135.56	$116.32
47	1,000	23.61	$94.44	$80.77		33.89	$135.56	$115.93
48	1,000	23.61	$94.44	$80.50		33.89	$135.56	$115.54
49	1,000	23.61	$94.44	$80.23		33.89	$135.56	$115.16
50	1,000	23.61	$94.44	$79.97		33.89	$135.56	$114.78

51	1,000	23.61	$94.44	$79.70		33.89	$135.56	$114.40
52	1,000	23.61	$94.44	$79.44		33.89	$135.56	$114.02
53	1,000	23.61	$94.44	$79.17		33.89	$135.56	$113.64
54	1,000	23.61	$94.44	$78.91		33.89	$135.56	$113.26
55	1,000	23.61	$94.44	$78.65		33.89	$135.56	$112.88
56	1,000	23.61	$94.44	$78.39		33.89	$135.56	$112.51
57	1,000	23.61	$94.44	$78.13		33.89	$135.56	$112.13
58	1,000	23.61	$94.44	$77.87		33.89	$135.56	$111.76
59	1,000	23.61	$94.44	$77.61		33.89	$135.56	$111.39
60	1,000	23.61	($13,551.86)	($11,099.01)		33.89	($8,852.89)	($7,250.55)

Comparison of Hybrid Honda Civic with Standard Honda Civic

	Monthly miles you drive	1,000			
	Cost per gallon of gas	$4.00			
	Interest rate	4.00%			
	Ratio of city to highway miles	City	50%	Highway	50%
	Input data		Hybrid	Standard	Difference
	Miles per gallon	City	40	25	
		Highway	45	36	
	MSRP		$25,020	$16,480	$8,540
	Output				
	PV cost of gas		$5,128	$7,361	-$2,232
	PV of cash from sales		-$11,176	-$7,362	-$3,815
	PV of overall cost		-$18,972	-$16,479	
	Advantage to Hybrid				-$2,493