

MBA Teaching Note 08-02
Net Present Value Analysis of the Purchase of a Hybrid Automobile¹

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, 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. My research assistant collected the following information in the spring of 2009, during which regular fuel was about \$2 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 \$23,834. A standard Civic gets about 25 city miles and 36 highway miles to a gallon and has a MSRP of \$16,636.

Now let us 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 the car five years. We also assume based on used car sales data that after five years, you can sell the standard Civic for \$4,743.49 and the hybrid Civic for \$7,201.59. 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. 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 23.61 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) for 33.89 gallons. The monthly cost of gasoline would, therefore, be \$47.22 for the hybrid (23.61 x \$2.00) and \$67.78 (33.89 x \$2.00) for the standard.

The cash flows from use of the car are outflows for gasoline, but there is an inflow in the last month in the form of its expected salvage value. You have to make sure the signs are properly handled when adding up to get the overall net present value.

¹I appreciate the research assistance of Pratik Dhar on this exercise.

²If 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. This advantage would flow to both the hybrid and the standard. The hybrid costs more, but it is not clear how the spreading out of this tax deduction for the cost would affect the relative attraction of one vehicle over the other. Only an analysis would be able to determine the effect.

I chose a discount rate of 2%, which I am treating as essentially equal 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 2% annual rate is treated as a $2\%/12 = 0.167\%$ monthly rate.

Summing up the present values of the monthly cash flows, we see that the present value of the fuel cost is \$2,694 for the hybrid and \$3,867 for the standard, a difference of \$1,173. This figure might surprise you. It is fairly small and amounts to only about \$235 a year, or about \$20 a month, over this five-year period. The present value of the resale value is \$6,517 for the hybrid and \$4,292 for the standard, an advantage of \$2,224 for the hybrid, but this mostly occurs because of the hybrid's higher cost. The total present value advantage to the hybrid is $\$1,173 + \$2,224 = \$3,397$. The hybrid costs \$7,198 more. Hence, the NPV of choosing a hybrid over a standard is $\$3,397 - \$7,198 = -\$3,801$. In this case, the hybrid cannot be financially justified.

Of course, a lot of people use the payback method. As we discuss in this course, this is not the appropriate method, but let us see what it tells us. Typically cash flows are not discounted when using the payback method. Thus, the annual operating differential is easily found. The cost of fuel for the hybrid is \$47.22 a month and for the standard is \$33.89, a difference of \$13.33 a month. Thus, at a cost differential of \$7,198, it would take $\$7,198/\$13.33 = 540$ (approximately) months or 45 years to recover the cost differential. The resale value would reduce this slightly but not enough to make a difference.

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 say 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.

Going back to the case of gasoline at \$2 a gallon, how miles of driving would make the hybrid more attractive? It turns out that changing the monthly miles to between 4,000 and 4,500 miles a month would give the hybrid have the same effective cost as the standard. That is a lot of driving but might be reasonable for businesses with vehicles constantly on the road.

Combining these two situations, it would take about 26,000 miles a year and \$4 gas to justify the hybrid.

It is also the case that a hybrid is less efficient with more highway miles. On the highway, the standard engine kicks in, so a hybrid is much better for city driving, but of course, the more city driving, the fewer miles one is likely to drive.

In addition, a hybrid is also more advantageous for large vehicles. We have conducted a full study of all hybrids that exist in standard versions and found that hybrid Chevy Tahoes and GMC Yukons can be financially justified with reasonable input values.

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 50,000 miles or more a year assuming \$2 gas. Of course, a business with vehicles that drive a lot of miles, such as a taxi or delivery service, might be able to justify 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 Cost	Gallons of Gas	Cost of Gas	PV of Cost
	0							
	1	1,000	23.61	\$47.22	\$47.14	33.89	\$67.78	\$67.67
	2	1,000	23.61	\$47.22	\$47.07	33.89	\$67.78	\$67.55
	3	1,000	23.61	\$47.22	\$46.99	33.89	\$67.78	\$67.44
	4	1,000	23.61	\$47.22	\$46.91	33.89	\$67.78	\$67.33
	5	1,000	23.61	\$47.22	\$46.83	33.89	\$67.78	\$67.22
	6	1,000	23.61	\$47.22	\$46.75	33.89	\$67.78	\$67.10
	7	1,000	23.61	\$47.22	\$46.67	33.89	\$67.78	\$66.99
	8	1,000	23.61	\$47.22	\$46.60	33.89	\$67.78	\$66.88
	9	1,000	23.61	\$47.22	\$46.52	33.89	\$67.78	\$66.77
	10	1,000	23.61	\$47.22	\$46.44	33.89	\$67.78	\$66.66
	11	1,000	23.61	\$47.22	\$46.37	33.89	\$67.78	\$66.55
	12	1,000	23.61	\$47.22	\$46.29	33.89	\$67.78	\$66.44
	13	1,000	23.61	\$47.22	\$46.21	33.89	\$67.78	\$66.33
	14	1,000	23.61	\$47.22	\$46.13	33.89	\$67.78	\$66.22
	15	1,000	23.61	\$47.22	\$46.06	33.89	\$67.78	\$66.11
	16	1,000	23.61	\$47.22	\$45.98	33.89	\$67.78	\$66.00
	17	1,000	23.61	\$47.22	\$45.90	33.89	\$67.78	\$65.89
	18	1,000	23.61	\$47.22	\$45.83	33.89	\$67.78	\$65.78
	19	1,000	23.61	\$47.22	\$45.75	33.89	\$67.78	\$65.67
	20	1,000	23.61	\$47.22	\$45.68	33.89	\$67.78	\$65.56
	21	1,000	23.61	\$47.22	\$45.60	33.89	\$67.78	\$65.45
	22	1,000	23.61	\$47.22	\$45.52	33.89	\$67.78	\$65.34
	23	1,000	23.61	\$47.22	\$45.45	33.89	\$67.78	\$65.23
	24	1,000	23.61	\$47.22	\$45.37	33.89	\$67.78	\$65.12
	25	1,000	23.61	\$47.22	\$45.30	33.89	\$67.78	\$65.01
	26	1,000	23.61	\$47.22	\$45.22	33.89	\$67.78	\$64.91
	27	1,000	23.61	\$47.22	\$45.15	33.89	\$67.78	\$64.80
	28	1,000	23.61	\$47.22	\$45.07	33.89	\$67.78	\$64.69
	29	1,000	23.61	\$47.22	\$45.00	33.89	\$67.78	\$64.58
	30	1,000	23.61	\$47.22	\$44.92	33.89	\$67.78	\$64.47
	31	1,000	23.61	\$47.22	\$44.85	33.89	\$67.78	\$64.37
	32	1,000	23.61	\$47.22	\$44.77	33.89	\$67.78	\$64.26
	33	1,000	23.61	\$47.22	\$44.70	33.89	\$67.78	\$64.15
	34	1,000	23.61	\$47.22	\$44.62	33.89	\$67.78	\$64.05
	35	1,000	23.61	\$47.22	\$44.55	33.89	\$67.78	\$63.94
	36	1,000	23.61	\$47.22	\$44.47	33.89	\$67.78	\$63.83
	37	1,000	23.61	\$47.22	\$44.40	33.89	\$67.78	\$63.73
	38	1,000	23.61	\$47.22	\$44.33	33.89	\$67.78	\$63.62
	39	1,000	23.61	\$47.22	\$44.25	33.89	\$67.78	\$63.52
	40	1,000	23.61	\$47.22	\$44.18	33.89	\$67.78	\$63.41
	41	1,000	23.61	\$47.22	\$44.11	33.89	\$67.78	\$63.30
	42	1,000	23.61	\$47.22	\$44.03	33.89	\$67.78	\$63.20
	43	1,000	23.61	\$47.22	\$43.96	33.89	\$67.78	\$63.09
	44	1,000	23.61	\$47.22	\$43.89	33.89	\$67.78	\$62.99
	45	1,000	23.61	\$47.22	\$43.81	33.89	\$67.78	\$62.88
	46	1,000	23.61	\$47.22	\$43.74	33.89	\$67.78	\$62.78
	47	1,000	23.61	\$47.22	\$43.67	33.89	\$67.78	\$62.68
	48	1,000	23.61	\$47.22	\$43.59	33.89	\$67.78	\$62.57
	49	1,000	23.61	\$47.22	\$43.52	33.89	\$67.78	\$62.47
	50	1,000	23.61	\$47.22	\$43.45	33.89	\$67.78	\$62.36
	51	1,000	23.61	\$47.22	\$43.38	33.89	\$67.78	\$62.26
	52	1,000	23.61	\$47.22	\$43.31	33.89	\$67.78	\$62.16
	53	1,000	23.61	\$47.22	\$43.23	33.89	\$67.78	\$62.05
	54	1,000	23.61	\$47.22	\$43.16	33.89	\$67.78	\$61.95
	55	1,000	23.61	\$47.22	\$43.09	33.89	\$67.78	\$61.85
	56	1,000	23.61	\$47.22	\$43.02	33.89	\$67.78	\$61.74
	57	1,000	23.61	\$47.22	\$42.95	33.89	\$67.78	\$61.64
	58	1,000	23.61	\$47.22	\$42.87	33.89	\$67.78	\$61.54
	59	1,000	23.61	\$47.22	\$42.80	33.89	\$67.78	\$61.44
	60	1,000	23.61	\$47.22	\$42.73	33.89	\$67.78	\$61.33
Resale value	60			\$7,201.59	\$6,516.81		\$4,743.49	\$4,292.44
PV cost of gas					\$2,694.14			\$3,866.88

Comparison of Hybrid Honda Civic with Standard Honda Civic

Monthly miles you drive	1,000			
Cost per gallon of gas	\$2.00			
Interest rate	2.00%			
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		\$23,834	\$16,636	\$7,198
Resale value		\$7,202	\$4,743	
Output				
PV cost of gas		\$2,694	\$3,867	-\$1,173
PV of cash from resale		\$6,517	\$4,292	\$2,224
PV of overall cost		-\$20,011	-\$16,210	
Advantage to Hybrid				-\$3,801