## ILLUSTRATION 3.2

### Are Hybrid Gasoline-Electric Cars Optimal? Analysis at the Margin

Heightened concern about U.S. dependence on imported petroleum, particularly Middle Eastern oil, has fueled the interest of both policymakers and consumers in new, fuel-saving technologies for automobiles. While Bush Administration officials and environmentalists wrangle over which new automotive technology is best for America in the long run, auto buyers can now make the switch from gasoline cars to so-called hybrid cars that get their power from a combination of electric batteries coupled with a relatively small gasoline-powered engine.

Honda Motor Co. offers two models of such gas-electric cars—the Insight and the hybrid version of its Civic—and Toyota Motor Corp. covers the hybrid niche of the auto market with its Prius. The initial sales of hybrid autos proved disappointing for both automakers. Then the run-up in gasoline prices surrounding the war in Iraq stimulated interest and sales in the U.S. auto market. Toyota's sales of its Prius increased 29 percent in 2002, and Honda saw sales of its hybrid Civic jump 32 percent in February 2002. In spite of this recent interest, hybrids account for only a bite-sized piece of the U.S. car market.

Beginning in 1993, the Clinton-Gore Administration initiated a $1.5 billion government research program called "Partnership for a New Generation of Vehicles" with the primary objective of developing a gas-electric car that could achieve 80 miles per gallon (mpg). Currently, none of these new cars makes the 80-mpg target that Vice President Al Gore hoped would be forthcoming from the program. The accompanying table shows the fuel economy for the currently available hybrids, all of which fall well below the 80-mpg benchmark. Many scientists, including those at the National Academy of Sciences, believe the 80-mpg hybrid isn't "economically viable" at current gasoline prices and costs for producing gas-electric cars. In other words, not enough consumers will find it optimal to switch from conventional cars to hybrids to achieve the large-scale efficiencies needed to make production profitable at prices low enough to justify switching from gasoline to hybrid technologies.

**Marginal Analysis of Switching to Various Hybrid Cars**

| | (1) Toyota Echo | (2) Toyota Prius | (3) Honda Insight | (4) Honda Civic/Hybrid |
|---|---|---|---|---|
| Type | Gasoline | Hybrid | Hybrid | Hybrid |
| Price | $13,000 | $20,000 | $21,000 | $21,000 |
| Fuel economy[a] | 38 mpg | 41 mpg | 51 mpg | 48 mpg |
| Gallons to drive 15,000 miles | 395 gallons | 366 gallons | 294 gallons | 312 gallons |
| Gallons saved | | 29 gallons | 101 gallons | 83 gallons |
| *MB*[b] | | $43.50 | $151.50 | $123 |
| *MC*[c] | | $350 | $400 | $400 |

[a]As reported in "Profiles: 2003 Autos," in the April 2003 issue of *Consumer Reports* (in miles per gallon [mpg]).

[b]Marginal benefit measured as the dollar value of fuel savings by switching from the Echo economy sedan to a hybrid, based on 15,000 miles and gasoline priced at $1.50 per gallon.

[c]Marginal cost of switching from Echo to hybrid is annual increase in opportunity cost of capital for purchasing the higher-priced vehicle, based on 5 percent opportunity cost.

*continued*

In this illustration, we apply marginal analysis to the decision car buyers make when they consider whether to switch from conventional cars to gas-electric hybrids. Our analysis makes some rather important simplifying assumptions to focus on the analytical process of making this decision but, in so doing, we can collect the key data required for computing marginal benefits and costs of making the switch and can show what makes switching technologies optimal.

To set a benchmark for decision making, let's suppose a hypothetical car buyer would choose a Toyota Echo, costing $13,000 and getting 38 miles per gallon, if he or she decides to buy a conventional gasoline-powered economy sedan capable of carrying five passengers. Of course, the buyer could choose from a number of small, economy sedans, but, to make the comparison reasonable, the benchmark car should have driving features similar to the hybrids—specifically, it should be small, carry five passengers, and have only modest ability to accelerate.

To decide whether switching from an Echo to a hybrid car is optimal, you know from our discussion of optimization theory in this chapter that car buyers will compare the marginal benefit and marginal cost of switching. The benefit of reduced fuel usage must be weighed against the higher cost of hybrid technology. To illustrate how these benefits and costs could be computed, let's consider a car buyer who plans to pay cash for a new car (instead of leasing or getting a car loan from a bank), then drive the new car 15,000 miles and sell it at the end of one year. By limiting the ownership period to one year, we avoid the modest complexities of multiperiod analysis, such as discounting future benefits and costs to get present values, while maintaining our focus on the key factors influencing marginal benefit and marginal cost. Since there is no particular reason to believe marginal benefits and costs will vary in a predictable way from year to year, it follows that the best decision for a one-year ownership period will be the same one for multiple years of ownership.[d]

First consider a Toyota Prius. The marginal benefit of switching to a Prius can be measured by the dollar value of the fuel savings. To make this computation, car buyers must consider how many miles they plan to drive and what they expect to pay for gasoline. Switching from the Echo to the Prius requires about 29 fewer gallons of gasoline to go 15,000 miles—the Prius needs 366 gallons (= 15,000 miles/41 mpg) and the Echo needs 395 gallons (= 15,000 miles/38 mpg). Suppose the expected price of gasoline is $1.50 per gallon; then the marginal benefit of higher fuel economy achieved by switching from an Echo to a Prius is $43.50 (= $1.50 $\times$ 29 gallons). Under our simplifying assumptions, the

[d]One cost item that could be higher for the more expensive hybrids than the cheaper Echo is the amount of depreciation in the value of the car. To the extent that hybrids suffer greater first-year depreciation than the benchmark Echo, the computed marginal costs of the hybrids shown in the table will understate the true marginal costs. In this example, including accurate figures for first-year depreciation, which are unavailable given the short time these cars have been on the market, would only widen the gap between marginal benefits and marginal costs of the hybrid cars and does not change the conclusions.