The Role of Price in the Adoption of Plug-in Hybrid Electric Vehicles

Walter McManus, Research Professor
mcmanus@oakland.edu
School of Business Administration
Oakland University
Topics

• Adoption vs. diffusion is about who acts
• Patterns of diffusion: S-curves everywhere
• The Bass model
• Testing the Bass model: HEV sales
• Economic model
• Differences between consumers
  – Preference for PHEV
  – Sensitivity to price
• Implications
  • Based on joint work with Richard Senter, Jr.
Adoption/Diffusion and the S-Curve

Figure 1
Diffusion Rates in the U.S. for Selected Consumer Products

Electric Service
Refrigerator
Washing machine
Telephone
VCR
PC in household

“Adoption of New Technology” B. Hall and B. Khan, Department of Economics, University of California, Berkeley 2003
The Bass Model

\[ A'(t) = \left( p + q \frac{A(t)}{M} \right) (M - A(t)) \]
Figure 2: Schematic Diagram of the Consideration–Purchase Model
Data

- UM Survey of Consumers
- July-Nov 2008
- Representative sample for analysis of 1,763 adults
- Asked to stated the probability that they would purchase a PHEV: 0 to 100
- Scenarios
  - One before providing the consumer with information on price premium and benefits
  - Three scenarios with alternative price premiums
    - $2,500 ; $5,000; and $10,000
Discrete choice

- Replace current car (ICE)
  - PHEV: Value of driving new PHEV
  - ICE: Value of driving new ICE
- Do not replace
  - Value of driving current car
PHEVs in Use

- UM Survey (Price $2,500)
- UM Survey (Price $5,000)
- UM Survey (Price $10,000)
Diffusion of Technology in a Heterogeneous Consumer Population

• Adoption of new technology is a social process
• Need knowledge of factors that influence the social process:
  – Population averages and aggregates
  – Variability and covariability of the factors in the population
  – A representative sample can be used to estimate both averages and variances of the factors in the population

• We focus on two factors that influence adoption
  – Preference for PHEV
  – Sensitivity to price premium

• Neither factor is directly observable by researchers -- so we develop estimates of population means as well as the variability (and covariability) in the population
Preferences and attitudes

- Adopt: being an early adopter is important to me
- Avoid: avoiding fuel stations is important to me
- Green: being environment-friendly is important to me
- F Light: how often buy fluorescent lights?
  - Always to Never
<table>
<thead>
<tr>
<th></th>
<th>Average PHEV Preference</th>
<th></th>
<th>Average Price Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adopt</td>
<td>Avoid</td>
<td>Green</td>
</tr>
<tr>
<td>Very important</td>
<td>1</td>
<td>48.6</td>
<td>54.4</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>51.5</td>
<td>42.2</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>63.8</td>
<td>16.6</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>46.8</td>
<td>36.1</td>
</tr>
<tr>
<td>Not important</td>
<td>5</td>
<td>37.9</td>
<td>(3.0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>47.7</td>
<td>47.7</td>
</tr>
</tbody>
</table>

“Adopt” tells us very little about either PHEV leanings or price sensitivity.

The average preference for PHEV and “Avoid” are positively correlated.

The more important avoiding fuel stations, the greater the price sensitivity.

“Green” would parallel “Avoid” except for the spike at 3 & 4 (neutral, not very important).
Consumers willing to pay more than the price premium buy PHEVs

Buy PHEVs at $P_1$

Slope $P_1 =$ price premium

Do not buy PHEVs at $P_1$

Do not buy PHEVs at any positive price premium

Fixed plus variable preference for PHEV

Sensitivity to price premium
Consumers by PHEV preference and sensitivity to price premium

20% of the sample
From Preference to Demand
Consumers willing to pay more than the price premium buy PHEVs

The numerical values plotted are consumers' willingness to pay for PHEV in $ thousands.
Consumers willing to pay more than the price premium buy PHEVs

Price premium = $5,000

The numerical values plotted are consumers' willingness to pay for PHEV in $ thousands
Consumers willing to pay more than the price premium buy PHEVs

Price premium = $10,000

The numerical values plotted are consumers' willingness to pay for PHEV in $ thousands
Consumers willing to pay more than the price premium buy PHEVs

The numerical values plotted are consumers' willingness to pay for PHEV in $ thousands

Price premium = $15,000

Buy PHEV

Don't buy PHEV

Change in PHEV utility for a $1,000 premium increase
PHEVs as a share of annual U.S. light vehicle sales

- Adjusted for buying a new car: J.D. Power and Associates
- Adjusted for household buying at least one new car
- Adjusted for household buying new cars (number predicted)
Implications

• Adoption forecasts should not use cumulative sales as a proxy for adopters
• Sales forecasts need to consider the impact of price on demand
• Preference for PHEV and sensitivity to price are positively correlated: those who most want PHEVs are most sensitive to price
• Market demand for PHEVs is very sensitive to price: setting the right launch price is critical to success
Walter McManus, Research Professor
mcmanus@oakland.edu
School of Business Administration
Oakland University