

## Evaluating Tax Rebates for Hybrid Vehicles

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## Hybrid Electric Vehicles

- Hybrid Electric Vehicles (HEVs) combine an internal combustion engine with an onboard rechargeable energy storage system.
  - Most HEVs also include Regenerative braking to recharge onboard battery.
- HEVs provide environmental improvements in the use-phase (Turrentine, et al, 2006).
  - The current fleet reduces carbon emissions by an average of 6 tons per vehicle over its lifetime (Reynolds and Kandlikar, 2007).

## Hybrid Vehicles – The Preferred Technology to Reduce Transport Emissions?

- US and Canada are supporting hybrid technology.
  - United States of America
    - Federal tax incentives.
    - Several state and local tax and other non-monetary incentives.
  - Canada
    - Federal tax incentives – based on fuel efficiency.
    - Provincial tax incentives.
- Japan offers support for HEV's since 1998.

## Our Objective

- To evaluate the cost-effectiveness of hybrid tax rebates
- First Step – use model level sales data to answer
  - What is the effect of provincial tax rebates on the sales of HEVs?
  - Which vehicles are crowded out in the new car market.
  - How many consumers enter the new car market due to the rebate?

## Second Step

- Combine information from first step with fuel economy of HEV's, and other cars crowded out with average kilometers driven to calculate fuel savings from rebate.
- Based on expenditure on rebates calculate the cost per ton of carbon saved through the rebate.

## Related Literature

- Recent support to hybrid technology has encouraged economic analysis.
  - Diamond (2006) finds that gas prices, tax incentives, and average miles significantly influence hybrid vehicle adoption.
  - Gallagher and Muehlegger (2007) find that tax incentives, gasoline prices, and changing social preferences explain 12 percent, 28 percent, and 33 percent of increase in hybrid vehicle adoption.
  - Kahn (2007) evaluates the effect of ideology on the purchase of HEV's in the state of California.
  - Sallee (2007) studies the incidence of state and federal tax incentives offered to Toyota Prius owners.
  - Berestenuc and Li (2008) find that rising gas prices and government subsidies explain 17%, and 26% of the diffusion of hybrid vehicles.

## Our Paper

- Is similar as: One aim is to evaluate the effect of government incentives on the purchase of HEV's.
- Is Different from all the above papers besides Berestenuc and Li,
  - We have data on sales in the entire new car market.
  - We can estimate the effect of rebates on other cars: which cars did consumers switch away from?
  - We can also test if the rebate attracted entrants into the new car market.

## Berestenuc and Li (2008)

- Is similar to our paper as:
  - They also have data for the entire new car market for 22 MSA's in the USA
- Is Different from our paper
  - They estimate the impact of a rebate that varies across time (the US federal rebate).
  - Methodology,
    - Estimate a price elasticity for each model – which includes structure on cross-price effects.
    - Estimate a supply model.
    - Together determine rebate transferred to consumer.

## Preview of the Results

- A \$1000 increase in the rebate increased the market share of hybrids by approximately 26-36%.
  - 2006 share of hybrid car in light car sales – 0.53%
- After the rebate was implemented - approximately 36.7% of total sales can be attributed to the rebate.
- Consumers bought fewer intermediate passenger cars, and intermediate SUV's due to the rebate.
  - Larger numbers lost in intermediate passenger cars.
  - Other vehicle classes were not impacted.

## Hybrid Vehicle Sales in Canada

| Model                     | 2000       | 2001       | 2002       | 2003       | 2004        | 2005        | 2006        | 2007         |
|---------------------------|------------|------------|------------|------------|-------------|-------------|-------------|--------------|
| Chevrolet Malibu Hybrid   | 0%         | 0%         | 0%         | 0%         | 0%          | 0%          | 0%          | 0.03%        |
| Ford Escape               | 0%         | 0%         | 0%         | 0%         | 7%          | 17%         | 7%          | 7%           |
| Honda Accord              | 0%         | 0%         | 0%         | 0%         | 1%          | 11%         | 6%          | 2%           |
| Honda Civic               | 0%         | 0%         | 51%        | 61%        | 8%          | 7%          | 16%         | 14%          |
| Honda Insight             | 39%        | 21%        | 14%        | 2%         | 0.3%        | 0.1%        | 0.2%        | 0.03%        |
| Lexus GS450H              | 0%         | 0%         | 0%         | 0%         | 0%          | 0%          | 2%          | 1%           |
| Lexus LS 600H             | 0%         | 0%         | 0%         | 0%         | 0%          | 0%          | 0%          | 1%           |
| Lexus RX400H              | 0%         | 0%         | 0%         | 0%         | 0%          | 15%         | 9%          | 8%           |
| Nissan Altima Hybrid      | 0%         | 0%         | 0%         | 0%         | 0%          | 0%          | 0%          | 2%           |
| Saturn Aura Hybrid        | 0%         | 0%         | 0%         | 0%         | 0%          | 0%          | 0%          | 0.5%         |
| Saturn Vue Hybrid         | 0%         | 0%         | 0%         | 0%         | 0%          | 0%          | 2%          | 4%           |
| Toyota Camry Hybrid       | 0%         | 0%         | 0%         | 0%         | 0%          | 0%          | 24.2%       | 39%          |
| Toyota Highlander Hybrid  | 0%         | 0%         | 0%         | 0%         | 0%          | 12%         | 10%         | 4%           |
| Toyota Prius              | 61%        | 79%        | 35%        | 37%        | 83%         | 37%         | 24%         | 19%          |
| <b>Total Hybrid Sales</b> | <b>426</b> | <b>495</b> | <b>513</b> | <b>671</b> | <b>2303</b> | <b>5124</b> | <b>8924</b> | <b>14828</b> |

Source: Polk Automotive Canada.

## US State and Local Policies

| HOV Lanes    | Income Tax Credit | Sales Tax Exemption | Vehicle Emissions Test Exemption | State Government Purchasing Requirement | Registration or Excise Tax Exemption of Rebate | Parking Fee Reduction or Exemption (cities) |
|--------------|-------------------|---------------------|----------------------------------|---|--|---|
| AZ (pilot)   | CO                | CT (HE)             | CO (HE)                          | MN                                      | DC   | Albuquerque, NM                             |
| CA (HE)      | MD*               | DC                  | MD                               | NM                                      | IL (HE)  | Austin, TX                                  |
| CO (on hold) | NY (HE)           | ME*                 | WA                               | NY                                      | NM   | Baltimore, MD                               |
| FL           | OR                | NM (HE)             |                                  | WI                                      | PA   | Ferndale, MI                                |
| GA (on hold) | SC                | NY (HE)             |                                  |   |  | Huntington, NY                              |
| NJ           | UT                | WA (2009-11)        |                                  |   |  | Los Angeles, CA                             |
| NY (pilot)   | WV*               |                     |                                  |   |  | New Haven, CT                               |
| UT           | PA                |                     |                                  |   |  | Salt Lake City, UT                          |
| VA           |                   |                     |                                  |   |  | San Antonio, TX                             |
|              |                   |                     |                                  |   |  | San Jose, CA                                |
|              |                   |                     |                                  |   |  | Santa Monica, CA                            |
|              |                   |                     |                                  |   |  | Vail, CO                                    |
|              |                   |                     |                                  |   |  | Westchester, NY                             |

## Canadian Provincial Policies

| Province  | Vehicle Eligibility  | Rebate Amount and Timing  |
|---|--|---|
| <b>British Columbia</b><br>Policy announced: August 2000.<br>PST rate: 7% . with graduated increases for vehicles over \$55K. | All hybrid vehicles with regenerative braking (Cars and SUVs eligible)                   | 30% of tax paid up to \$500 for vehicles bought before July 31 <sup>st</sup> 2001.<br><br>30% of PST paid up to maximum of \$1000 after July 31 <sup>st</sup> 2001.<br><br>A point of sale reduction of all PST till a maximum of \$2000 after Feb 16 <sup>th</sup> 2005<br><br>Additional rebates in PST (reductions in graduated increase of PST over 7%) for hybrid vehicles over 62K. |
| <b>Prince Edward Island</b><br>Policy announced: March 2004<br>PST rate: 10%  | All Hybrid Vehicles are eligible   | All the PST paid until \$3000, for vehicles bought after March 30 <sup>th</sup> 2004.   |
| <b>Ontario</b><br>Policy announced: May 2001,<br>PST rate: 8%   | All hybrid passenger cars (with regenerative braking) eligible 2001, SUVs eligible 2002. | PST rebate upto a maximum of \$1000 for cars bought after May 10 <sup>th</sup> 2001.<br><br>Hybrid SUVs and trucks included June 18 <sup>th</sup> , 2002.<br><br>A point of sale reduction of all PST till a maximum of \$2000 after March 23 <sup>rd</sup> , 2006.   |
| <b>Quebec</b><br>Policy Announced: March 2006.<br>PST: 7.875%   | See Notes (1) below  | All PST paid to a maximum of \$1000 for vehicles bought after March 23 <sup>rd</sup> 2006.  |
| <b>Manitoba</b><br>Policy announced, November 15th 2006<br>PST rate: 7% .   | See Notes (2) below  | Flat \$2000 rebate for all vehicles bought after November 15 <sup>th</sup> 2006.  |

## Rebate Variable

- Assuming that the transacted price for hybrid cars is at least as high as the base price we calculate a model specific rebate variable,

$$R_{mvt} = \min \left\{ \eta_{vt} (PST_v * BP_m), Limit_{vt} \right\}$$

$\eta_{vt}$  is the proportion of  $PST$  returned,  $BP$  is base price, and  $Limit$  is the maximum  $PST$  rebate.

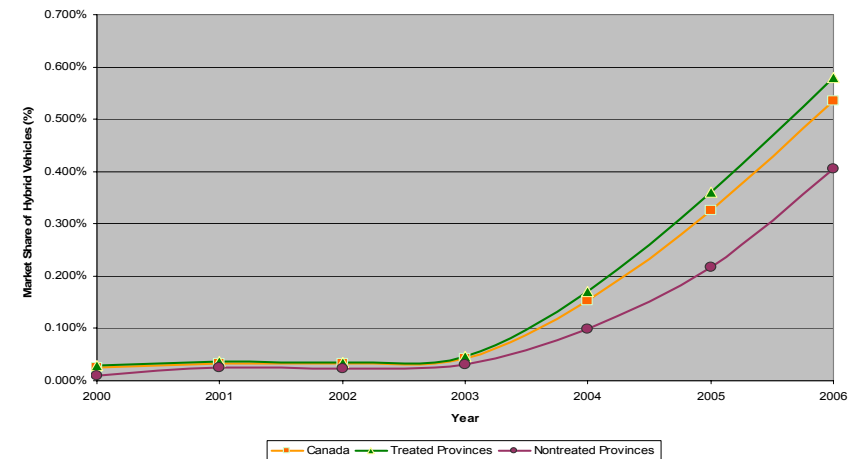
## Hybrid Vehicles Base Prices

| Model                | Year | Base Price |
|----------------------|------|------------|
| Civic Hybrid         | 2008 | \$ 26,350  |
| Insight              | 2000 | \$ 26,000  |
| Accord Hybrid        | 2007 | \$ 38,090  |
| Prius                | 2008 | \$ 29,500  |
| Camry Hybrid         | 2008 | \$ 32,000  |
| Highlander Hybrid    | 2008 | \$ 41,075  |
| Lexus GS400h         | 2008 | \$ 71,000  |
| Lexus RX400h         | 2008 | \$ 55,050  |
| Lexus LSh            | 2008 | \$ 125,400 |
| Saturn Vue Greenline | 2008 | \$ 30,790  |
| Saturn Aura Hybrid   | 2008 | \$ 27,575  |
| Ford Escape Hybrid   | 2008 | \$ 31,499  |

## Rebate Maximums

| Province \ Year | 2000     | 2001       | 2002       | 2003       | 2004       | 2005       | 2006       |
|-----------------|----------|------------|------------|------------|------------|------------|------------|
| BC              | \$500.00 | \$630      | \$630      | \$630      | \$777      | \$2000     | \$2000     |
| Ontario         | \$ 0     | \$1,000.00 | \$1,000.00 | \$1,000.00 | \$1,000.00 | \$1,000.00 | \$2,000.00 |
| Manitoba        | \$ 0     | \$ 0       | \$ 0       | \$ 0       | \$ 0       | \$ 0       | \$ 0-      |
| PEI             | \$ 0     | \$ 0       | \$ 0       | \$ 0       | \$3000     | \$3000     | \$3000     |
| Quebec          | \$ 0     | \$ 0       | \$ 0       | \$ 0       | \$ 0       | \$ 0       | \$1,000.00 |

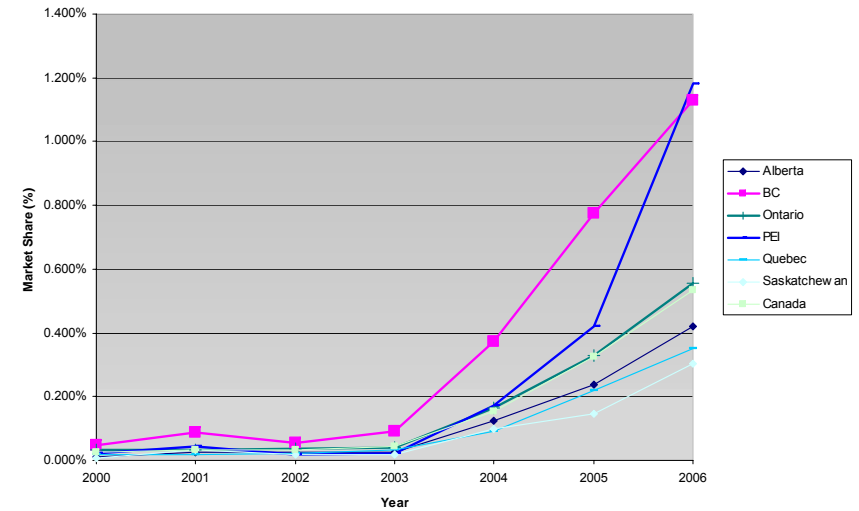
## Rebating and Non Rebating Provinces



## Hybrid Sales Across Provinces

| Province      | Passenger Cars |                        | Light Trucks |                        | Total Vehicle Sales |                        |
|---------------|----------------|------------------------|--------------|------------------------|---------------------|------------------------|
|               | Sales          | Market Share of Hybrid | Sales        | Market Share of Hybrid | Sales               | Market Share of Hybrid |
| Alberta       | 642            | 0.7%                   | 362          | 0.2%                   | 1004                | 0.4%                   |
| BC            | 1499           | 1.5%                   | 624          | 0.7%                   | 2123                | 1.1%                   |
| Manitoba      | 207            | 1.0%                   | 61           | 0.3%                   | 268                 | 0.6%                   |
| Nbrunswick    | 94             | 0.5%                   | 21           | 0.1%                   | 115                 | 0.3%                   |
| Nfoundland    | 28             | 0.2%                   | 16           | 0.1%                   | 44                  | 0.2%                   |
| Novascotia    | 150            | 0.5%                   | 28           | 0.2%                   | 178                 | 0.4%                   |
| Ontario       | 2454           | 0.8%                   | 889          | 0.3%                   | 3343                | 0.6%                   |
| PEI           | 51             | 1.7%                   | 7            | 0.4%                   | 58                  | 1.2%                   |
| Quebec        | 1053           | 0.4%                   | 337          | 0.2%                   | 1390                | 0.4%                   |
| <b>Canada</b> | <b>6178</b>    | <b>0.7%</b>            | <b>2345</b>  | <b>0.3%</b>            | <b>8523</b>         | <b>0.53%</b>           |

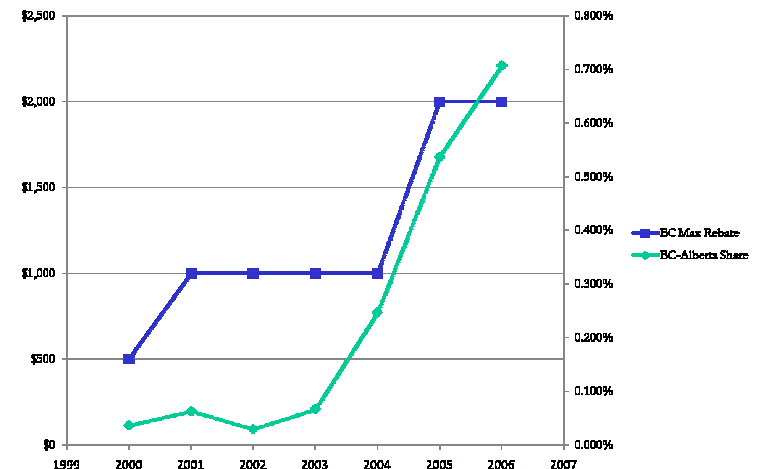
## Some Selected Provinces



## One Should Be Concerned About

- Is our rebate variable just capturing a cross-sectional preference for hybrid cars?
  - Do Provinces that offer rebates have an inherent and unchanging preference for hybrid cars?
- Is our rebate variable capturing a Canada wide increase in the preference for hybrid vehicles?
  - In addition to the effect caused by fuel prices?

## Our Estimate



## Data

- DesRosiers Automotive Consultants Inc. – vehicle sales counts, by make and model, by province, yearly 1989-2006.
  - Only has Toyota Prius and Honda Insight among HEV's.
- Polk Automotive Canada provide provincial sales counts for all Hybrid Models sold in Canada (until 2007).
  - These include Honda Accord, Civic Hybrid, other Toyota and Lexus Models, Ford Escape Hybrid, and the Saturn Vue Greenline.
- Fuel Economy Data from EPA
- Model Generation Data from Wikipedia.
- Province level demographics, CPI – fuel, private transport, vehicle km's, total vehicles registered from STAT Canada.

## Theory Underlying Estimation

- Utility to individual  $i$  in province  $v$  from purchasing model  $m$  in class  $C$  is given by

$$u_{imv} = \alpha[y_i - p_{mv}] + \beta x_{mv} + \xi_{mv} + \varepsilon_{imv}$$

where,  $x_{mv}$  - observed attributes,  $\xi_{mv}$  - unobserved attributes,  $y$  is income and  $p$  is the price of the model,  $\varepsilon$  is a mean zero random variable.

## Theory Underlying Estimation

- Assuming that  $p_{mv} = p_m - R_{mv}$  and  $\xi_{mv} = \xi_m + \Delta\xi_{cv}$ , and that  $\varepsilon$  follows type I extreme value the market share of a model in a province is

$$s_{mv} = \frac{\exp(\beta x_{mv} - \alpha(p_{mv} - R_{mv}) + \xi_m + \Delta\xi_{cv})}{1 + \sum_k \exp(\beta x_{kv} - \alpha(p_{mv} - R_{mv}) + \xi_k + \Delta\xi_{cv})}$$

## Estimating Equation – Multinomial Logit

- To compute the estimating equation we calculate the odds of choosing a model  $m$  relative to the outside good. Taking logs of the equation we get the following estimating equation.

$$\ln(s_{mvt}) - \ln(s_{ovt}) = \beta_0 + \beta_1 R_{mvt} + \beta_2 \frac{P_{vt}^{gas}}{MPG_{mt}} + \theta_m + \gamma_{vct}$$

$\theta$  - model generation fixed effect and  $\gamma$  refers to - province, class and year fixed effects.  $\beta_1$  captures the impact of the rebate.

## Fuel Cost and Other Variables

- Fuel Cost variable is calculated as CPI for gasoline by province and year divided by fuel economy of the model.
- Model\*generation dummy captures unobserved and observed model specific attributes (including retail price)
  - Is constant across provinces

## Other Fixed Effects

- A province\*class year dummy captures  $\Delta\xi_{cv}$ .
  - This will control for a time in-varying preference in a particular province for a certain class of vehicles.
    - Geography, urban sprawl, education, income etc. could create such a preference.
- A class\*year dummy captures preferences for a class over a particular year.
  - This will control for a time (but not space) varying preference for a particular class.
    - Will not capture local network externalities due to the presence of more hybrid vehicles.

## Results

| Dependent Variable                      | Logit               |
|---|---------------------|
| Rebate by Model, Province and Time (\$) | 0.00036<br>(5.20)** |
| Fuel Cost by Model and Province - EPA   | 0.08385<br>(2.40)*  |
| Province Year Fixed Effects             | Yes                 |
| Province Class Fixed Effects            | Yes                 |
| Constant                                | Yes                 |
| Observations                            | 17240               |
| R-squared                               | 0.18                |

Absolute value of t statistics in parentheses

\* significant at 5%; \*\* significant at 1%

## Issues with Multinomial Logit

- The multinomial logit implies that a large proportion of new hybrid cars are bought by people switching in from the outside good.
  - The rebate raises hybrid car sales by attracting people who would not have otherwise bought cars at all.
- We can test this possibility.

## Results

|                               | (1)                 | (2)                | (3)                    |
|-------------------------------|---------------------|--------------------|------------------------|
| Dependent Variable            | Log Sales           | Log Sales          | Log Sales              |
| Maximum Rebate                | 0.00006<br>(3.02)** | -0.00002<br>(1.18) | -0.00000<br>(0.34)     |
| CPI Private<br>Transportation |                     |                    | 0.00017<br>(0.06)      |
| Population 18 +               |                     |                    | 0.00000008<br>(3.63)** |
| GDP per Capita 1997 \$        |                     |                    | 31.28698<br>(6.27)**   |
| Year Dummies                  |                     | Yes                | Yes                    |
| Constant                      | Yes                 | Yes                | Yes                    |
| Observations                  | 180                 | 180                | 180                    |
| Number of groups              | 10                  | 10                 | 10                     |
| R-squared                     | 0.0513              | 0.7334             | 0.8153                 |
| F statistic                   | 9.13                | 23.23              | 31.32                  |

## Next Estimating Equation

- Assuming that consumers do not switch into buying a new car from the outside good, we take the size of the new car market as given for our purposes

$$\ln(s_{mvt}) = \beta_0 + \beta_1 R_{mvt} + \beta_2 \frac{P_{vt}^{gas}}{MPG_{mt}} + \theta_m + \gamma_{vct}$$

$\theta$  - model generation fixed effect and  $\gamma$  refers to - province, class and year fixed effects.  $\beta_1$  captures the impact of the rebate.

## Results with a Model Specific Variable

|                        | (1)                 | (2)                 | (3)                 | (4)                 |
|------------------------|---------------------|---------------------|---------------------|---------------------|
| Dependent Variable     | Log Market Share    | Log Market Share    | Log Market Share    | Log Market Share    |
| Rebate by Model (\$)   | 0.00038<br>(5.16)** | 0.00030<br>(4.26)** | 0.00032<br>(4.56)** | 0.00034<br>(5.00)** |
| Fuel Cost - EPA        | No                  | 0.01982<br>(0.80)   | -0.00338<br>(0.12)  | -0.00085<br>(0.03)  |
| Province Dummies       | No                  | Yes                 | No                  | No                  |
| Year Dummies           | No                  | Yes                 | No                  | No                  |
| Province Year Dummies  | No                  | No                  | Yes                 | No                  |
| Province Class Dummies | No                  | No                  | No                  | Yes                 |
| Class Year Dummies     | No                  | No                  | No                  | Yes                 |
| Constant               | Yes                 | Yes                 | Yes                 | Yes                 |
| Observations           | 38110               | 36640               | 36640               | 36640               |
| Number of groups       | 895                 | 847                 | 847                 | 847                 |
| R-squared              | 0.0007              | 0.0920              | 0.0955              | 0.2130              |
| F statistic            | 26.59               | 129.47              | 20.78               | 24.70               |

## Results Using Rebate Maximums

|                         | (1)                 | (2)                 | (3)                 | (4)                  |
|-------------------------|---------------------|---------------------|---------------------|----------------------|
| Dependent Variable      | Log Market Share    | Log Market Share    | Log Market Share    | Log Market Share     |
| Hybrid * Maximum Rebate | 0.00034<br>(5.12)** | 0.00030<br>(4.65)** | 0.00030<br>(4.69)** | 0.00036<br>(5.82)**  |
| Maximum Rebate (\$)     | 0.00001<br>(1.24)   | -0.00003<br>(2.18)* | 0.00005<br>(1.63)   | -0.00004<br>(3.18)** |



## Vehicle Class

- We differentiate individual car model data by the following categories, these are:
  - Passenger Cars
    - Subcompact, Compact, Intermediate, Sports, Luxury Sports, Luxury, Luxury High End.
  - Light Trucks
    - Compact Sport Utility, Intermediate Sport Utility, Large Sport Utility, Small Pickup Truck, Large Pickup Truck, Small Van, Large Van, Luxury Sport Utility
  - Hybrid

## Market Share of Hybrids and Other Categories

| Size Class of Vehicles     | Market Share<br>percentage of Total Vehicle Sales |                  |
|----------------------------|---|------------------|
|                            | 2003  | 2006             |
| <i>Passenger Cars</i>      |   |                  |
| Compact PC                 | 25.4%   | 24.8%            |
| Hybrid                     | 0.04%   | 0.41%            |
| Intermediate PC            | 17.6%   | 14.1%            |
| Luxury High End PC         | 1.8%  | 1.4%             |
| Luxury PC                  | 2.7%  | 3.9%             |
| Luxury Sports PC           | 0.5%  | 0.4%             |
| Sports PC                  | 2.2%  | 2.0%             |
| Subcompact PC              | 4.1%  | 6.4%             |
| <i>Light Trucks</i>        |   |                  |
| Compact Sport Utility      | 7.0%  | 11.2%            |
| Hybrid                     | 0.0%  | 0.12%            |
| Intermediate Sport Utility | 6.6%  | 4.4%             |
| Large Pickup Truck         | 12.7%   | 12.7%            |
| Large Sport Utility        | 1.3%  | 1.1%             |
| Large Van                  | 1.7%  | 1.8%             |
| Luxury Sport Utility       | 2.0%  | 2.8%             |
| Small Pickup Truck         | 1.8%  | 3.0%             |
| Small Van                  | 12.5%   | 9.4%             |
| Passenger Cars             | 865,873   | 863,292          |
| Light Trucks               | 728,043   | 752,206          |
| Total Vehicle Sales        | <b>1,593,916</b>                                  | <b>1,615,498</b> |

## Results with Impacts of Different Classes

| Dependent Variable              | Log Market Share | Log Market Share | Log Market Share | Log Market Share |
|---------------------------------|------------------|------------------|------------------|------------------|
| Hybrid * Max Rebate             | 0.00031          | 0.00028          | 0.00030          | 0.00028          |
|                                 | (4.17)**         | (3.99)**         | (4.17)**         | (4.06)**         |
| Intermediate PC * Max Rebate    | -0.00026         | -0.00023         | -0.00023         | -0.00010         |
|                                 | (6.06)**         | (5.54)**         | (5.44)**         | (2.28)*          |
| Int Sports Utility * Max Rebate | -0.00017         | -0.00018         | -0.00017         | -0.00017         |
|                                 | (3.57)**         | (3.73)**         | (3.57)**         | (3.27)**         |
| Lux Highend PC*Max Rebate       | 0.00023          | 0.00028          | 0.00030          | -0.00009         |
|                                 | (4.34)**         | (5.45)**         | (5.82)**         | (1.58)           |
| Luxury PC* Max Rebate           | 0.00016          | 0.00016          | 0.00017          | -0.00007         |
|                                 | (3.20)**         | (3.14)**         | (3.46)**         | (1.30)           |

## Regression Results

- Provinces that gave a rebate saw an increase in the market share of HEV's.
- Reduced form results imply that
  - Intermediate Cars always lose from implementation of the policy.
  - Intermediate Sports Utilities also lose from the implementation of the policy in all specifications.

## Counterfactuals

- Using the simple specification – without impacts across different classes.

| BC    | Ontario  |        | PEI      |       | Quebec   |       |      |          |
|-------|----------|--------|----------|-------|----------|-------|------|----------|
|       | ΔHybrids | Sales  | ΔHybrids | Sales | ΔHybrids | Sales |      | ΔHybrids |
| 7.6   | 61       | -      | -        | -     | -        | -     | -    | -        |
| 19.3  | 151      | 65.3   | 198      | -     | -        | -     | -    | -        |
| 24.8  | 103      | 85.6   | 247      | -     | -        | -     | -    | -        |
| 28.6  | 160      | 126.2  | 262      | -     | -        | -     | -    | -        |
| 31.7  | 641      | 119.3  | 953      | 2.9   | 7        | -     | -    | -        |
| 487.7 | 1401     | 490.3  | 1936     | 15.3  | 24       | -     | -    | -        |
| 830.2 | 2202     | 2057.5 | 3475     | 27.6  | 55       | 467.6 | 1417 | -        |

- Overall approximately 36.7 % of the cars sold due to the rebate.

## Counterfactuals – Gasoline Saved

- Using the simple specification.

| Year | BC    | ONTARIO | PEI  | QUEBEC |
|------|-------|---------|------|--------|
| 2000 | 7.2   | -       | -    | -      |
| 2001 | 18    | 62.2    | -    | -      |
| 2002 | 23.9  | 83.3    | -    | -      |
| 2003 | 24.8  | 116.5   | -    | -      |
| 2004 | 24.9  | 102     | 2.3  | -      |
| 2005 | 325.1 | 374     | 11.6 | -      |
| 2006 | 462.9 | 1509.1  | 15.4 | 263.6  |

- In thousands of liters per year.
- Adjusted for average kilometers by vehicle by province and year

## Tax Rebate Outlays

- In thousands of dollars

| Year | BC     | ONTARIO | PEI   | QUEBEC |
|------|--------|---------|-------|--------|
| 2000 | 30.5   | -       | -     | -      |
| 2001 | 92.3   | 198     | -     | -      |
| 2002 | 59.4   | 247     | -     | -      |
| 2003 | 93     | 262     | -     | -      |
| 2004 | 395.2  | 953     | 19.7  | -      |
| 2005 | 2865.8 | 1309    | 68.3  | -      |
| 2006 | 4465.9 | 3516    | 158.5 | 909    |

- Based on the simple specification, and assuming that the hybrid is on the road for 15 years. the overall cost per liter of gas saved – .31\$, corresponds to a \$131 dollars per ton of CO2

## Conclusion

- Tax rebates are effective at increasing hybrid adoption.
  - On average provinces offering a tax rebate saw an increase in the share of hybrid vehicles.
- Market Shares of intermediate vehicles fell due to the rebate.
  - Robust to different specifications.

## Future Work

- Incorporate factors that make a Province offer the rebate?
- Finish counterfactuals.
- Extensions
  - The impact of hybrid rebate policies on domestic/import sales.
  - The impact of increasing fuel prices on domestic/import sales.