

Hybrid Cars and HOV Lanes

Sharon Shewmake



Hybrid Cars

- Internal combustion engine + battery and electric motor
- Better mileage
- Today's HEVs produce 1/3 to 1/2 less ozone precursors (NO_x) and GHG gasses

HOV Lanes



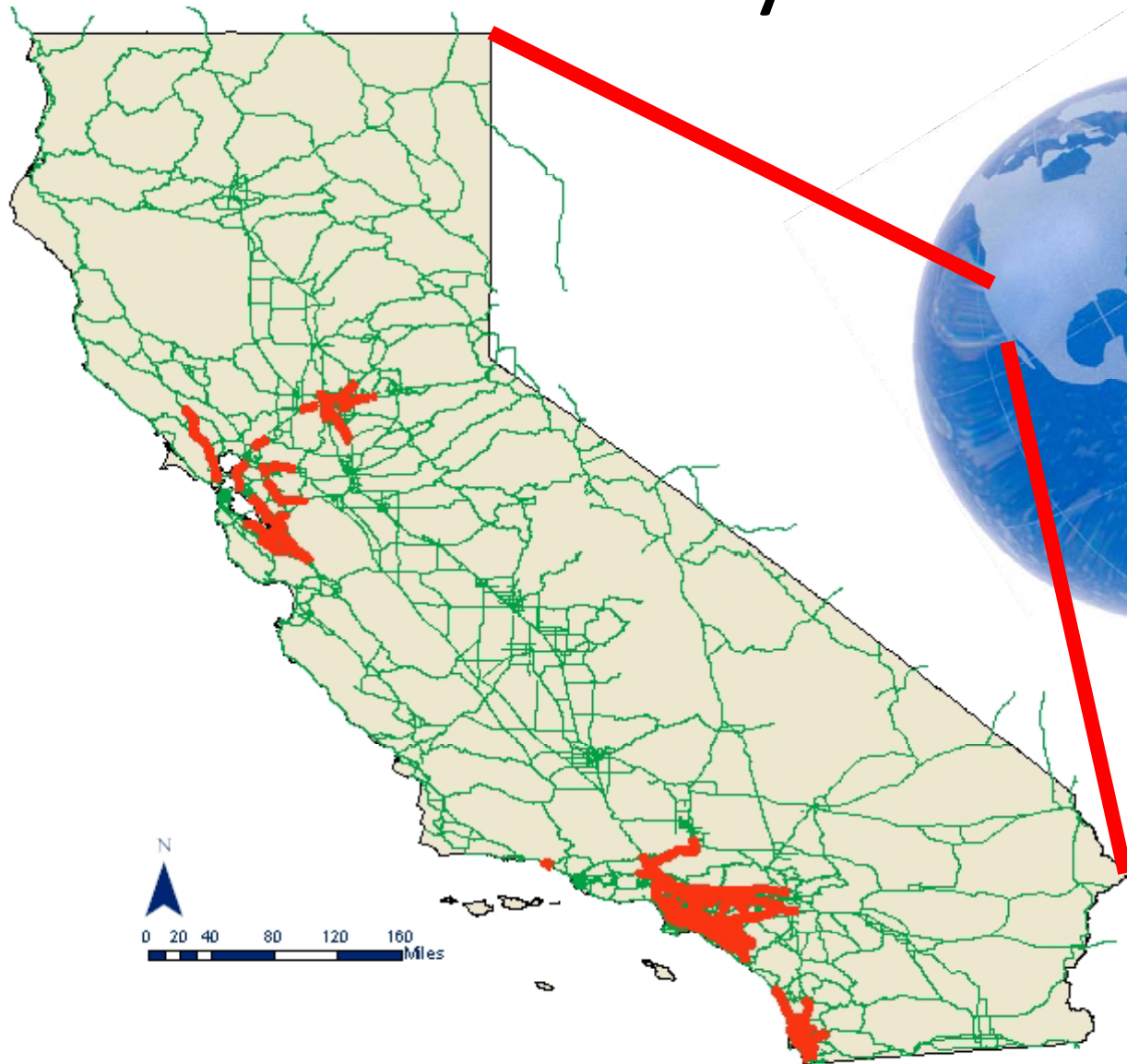
California Clean Air Stickers



Literature on Hybrid Demand

- Emerging literature on the impact of tax rebates, subsidies for hybrid cars (Sallee 2007, Chandra et al 2009, Leonard 2008)
- Previous literature found weak evidence that allowing hybrids into HOV lanes did not stimulate the purchase of hybrid cars (Diamond 2008, Gallagher and Muehlegger 2008)

Study Area



September 2004

Start of
California Clean
Air Sticker
Program

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May 2008

AutoTrader and
Ebay Data
Begins to Be
Collected

2007 Toyota Prius class A | Research 2007 Toyota
Toyota : Prius

Bidding has ended for this item

Sell an item like this or buy a similar item below.

Winning bid: US \$13,100.00
Get low monthly pay

Ended: Jan-03-09 11:46:39 PST
Shipping: Buyer responsible for shipping. Vehicle shipping included.
Sells to: Worldwide
Item location: long island city, NY, USA
History: 2 bids
Winning bidder: e***w (45 ☆)

You can also: Email to a friend

Listing and payment details: Show

Primary information about this AT Car ID: AT-F31B153

May 2008
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Collected

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[View & Print an AutoBiography® \(PDF\)](#)
A detailed brochure with photos, maps & more.

2006 Toyota Prius Hybrid

\$17,988 [Save this Car](#)

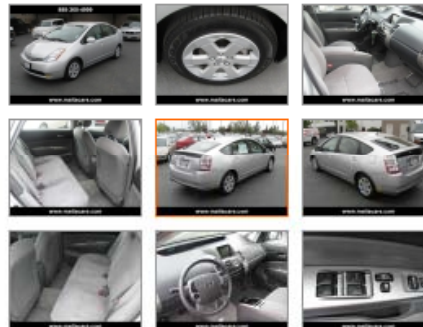
Thinking about a new Toyota Prius?
Check out our new inventory in stock today at Maita Toyota of Sacramento

Photos



\$17,988
Mileage: 56,562

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Contact this Seller

Maita Toyota of Sacramento



1-877-560-0606

Please ask for our Internet Dept

- LARGE INVENTORY-VOLUME PRICES!
- CERTIFIED PRE-OWNED CENTRAL

- See more information about us
- View our inventory
- Visit Our Website
- View a map and get directions
- Finance a vehicle with us

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2009 Prius



Learn more [click here](#)

\$1,000 cash back on the '09 Prius. Offer ends 7/6.

Primary information about this vehicle:

AT Car ID: AT-F882362



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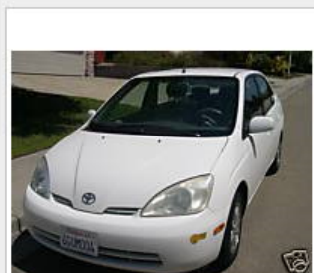
[Live Help](#)

2002 Toyota Prius | [Research 2002 Toyota](#) Toyota : Prius

Item number: 250446853731

You are signed in

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1 of 14

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Current bid: **US \$5,000.00**
Reserve not met

Your maximum bid: **US \$**
(Enter US \$5,100.00 or more)
[Get low monthly payments](#)

End time: **1 hour 47 mins** (Jun-24-09 19:44:39 PDT)
Shipping: Buyer responsible for vehicle pick-up or shipping. [Vehicle shipping quote is available.](#)

Sells to: United States
Item location: Antioch, CA, United States
History: [10 bids](#)
High bidder: n***n (66 ★)

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Meet the seller

Seller: [jee-6022](#) (0)
Member: since May-25-09 in United States

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- [Check the seller's feedback](#)
- [Review the vehicle history report](#)
- [Get tips and advice in the Buyer Checklist](#)
- ✓ This vehicle is eligible for up to \$50,000 in free [Vehicle Purchase Protection](#)

Listing and payment details: [Show](#)

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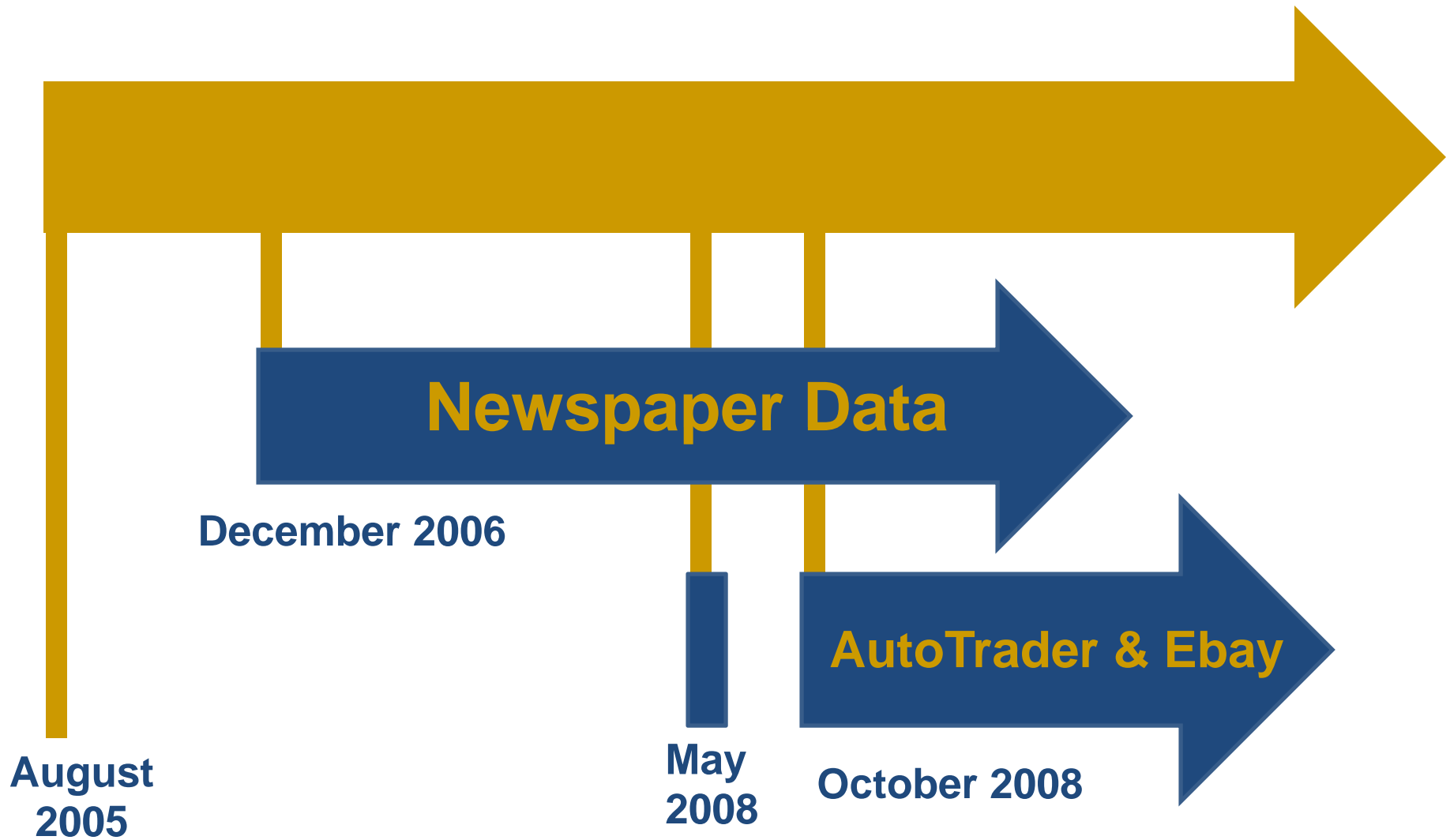
May 2008

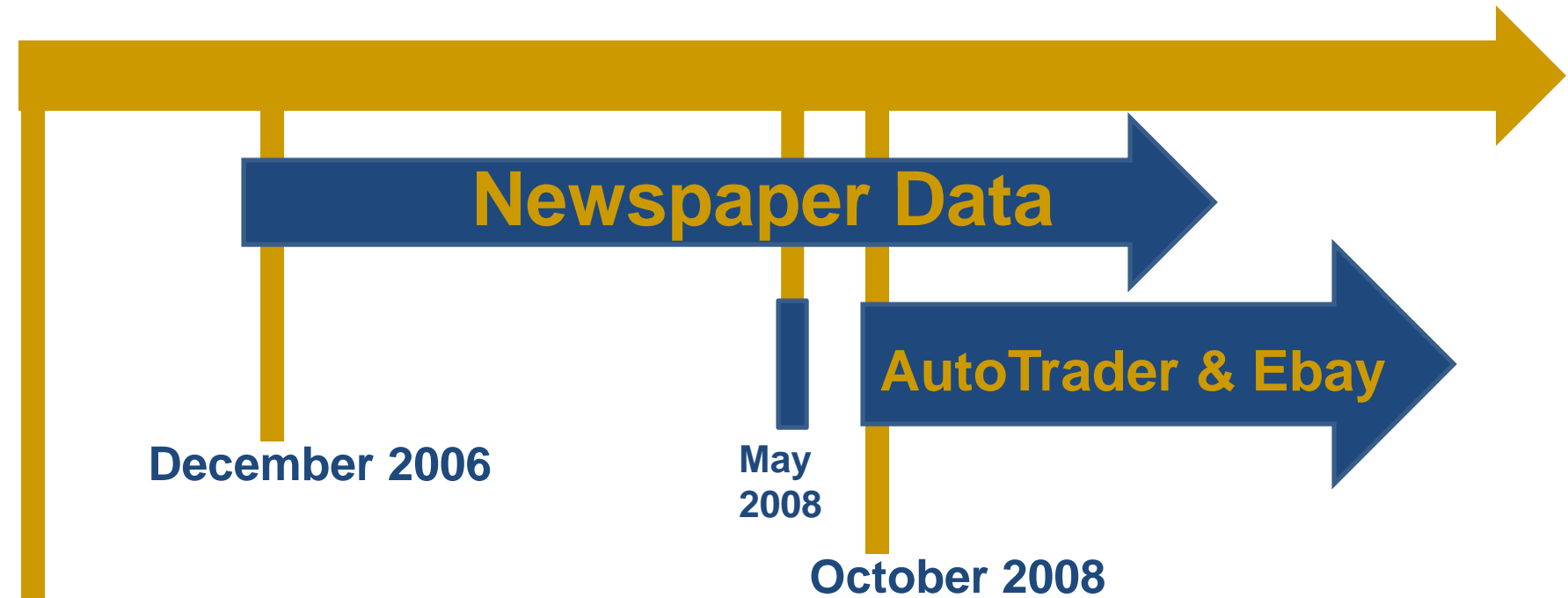
AutoTrader and
Ebay Data
Begins to Be
Collected

January 2011

Program
expected to end

Data





**August
2005**

Data Source	Number of Observations	Percentage of Data
Ebay	132	3.3
Autotrader.com	3,574	88.1
Newspaper Data	279	7.8
Sacramento Bee	141	3.5
San Francisco Chronicle	119	2.9
San Diego Union-Tribune	24	0.6
Los Angeles Times	68	1.7
Total	4,058	

Hedonic Model

- Any car can be described by the set of characteristics of the car:

$$Z = (z_1, z_2, \dots, z_n)$$

- The equilibrium price can thus be modeled as a function of the characteristics of the car:

$$P(Z) = P(z_1, z_2, \dots, z_n)$$

- We separate out the price of the sticker:

$$P(Z) = P_{\text{sticker}}(\text{sticker}) + P(z_2, z_3, \dots, z_n)$$

Evolution of the Sticker Value

$$P_{\text{sticker}}(t) = \int_t^T c_s e^{-r(s-t)} ds$$

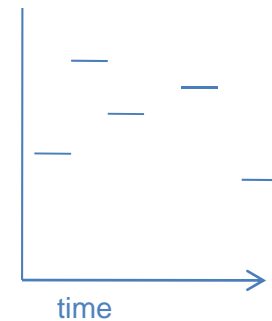
$$WTP(t) = \begin{cases} V_1 & \text{if } t < \text{February 2007} \\ \frac{c}{r} (1 - e^{-r(T-t)}) & \text{if } t \geq \text{February 2007} \end{cases}$$

Regressions

- Varies with each Season

$P(\text{sticker})$

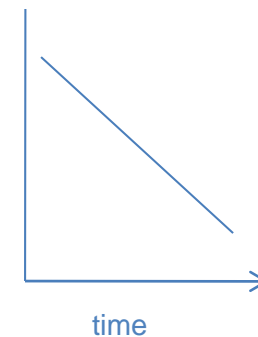
$$= \beta_{1,1} \text{sticker_season_1}_t + \beta_{1,2} \text{sticker_season_2}_t + \dots + \beta_{1,11} \text{sticker_season_11}_t$$



- Varies with Linear Time Trend

$P(\text{sticker})$

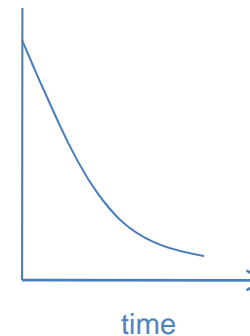
$$= \beta_1 \text{sticker_season_1}_t + \beta_2 \text{sticker}_t + \beta_3 \text{sticker}_t$$



- Varied with Non-Linear Time Trend

$P(\text{sticker})$

$$= \beta_1 \text{sticker_season_1}_t + \beta_2 \text{sticker}_t + \beta_3 \text{sticker}_t e^{r(T-t)}$$

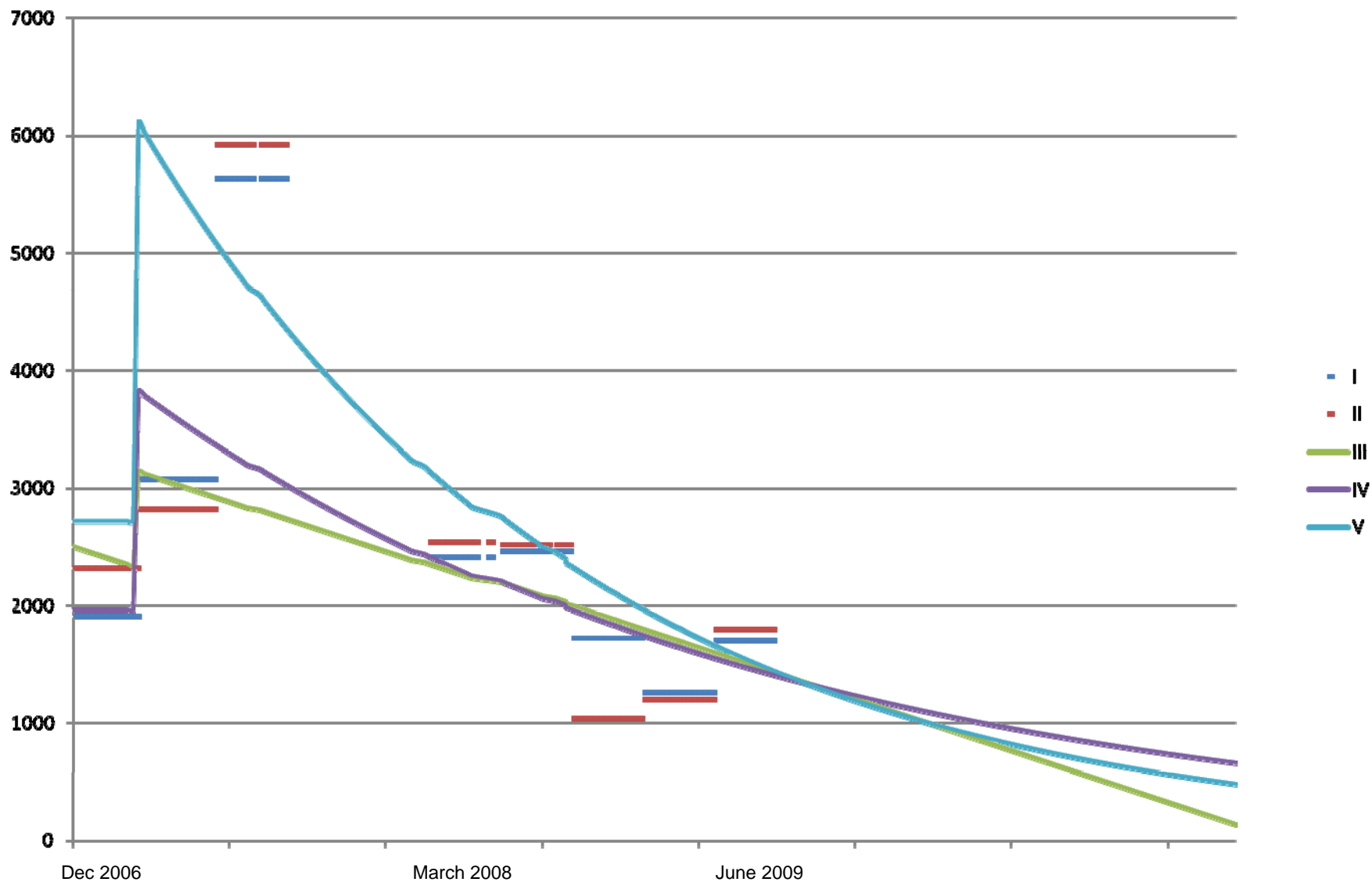


Regression

$$\begin{aligned} \ln(\text{Price}_{it}) = & \alpha + \beta_1 \text{sticker_season_1}_i + \beta_2 \text{sticker}_i + \beta_3 \text{sticker}_i e^{r(T-t)} \\ & + \beta_4 \text{mileage}_i + \sum_{j=1}^8 \beta_{5,j} \text{model}_{ij} + \sum_{j=2000}^{2007} \beta_{6,j} \text{modelyear}_{ij} \\ & + \beta_7 \text{bluetooth}_i + \beta_8 \text{mp3}_i + \beta_9 \text{navigation system}_i \\ & + \sum_{j=1}^8 \beta_{10,j} \text{source}_{ij} + \sum_{j=1}^6 \beta_{11,j} \text{location}_{ij} + \sum_{j=1}^{10} \beta_{12,j} \text{season}_{ij} \\ & + \sum_{j=1}^{10} \beta_{13,j} \text{calendaryear} \times \text{modelyear}_{ij} \\ & + \sum_{j=1}^{10} \beta_{14,j} \text{calendaryear} \times \text{mileage}_{ij} + \varepsilon_i \end{aligned}$$

	I	II	III	IV	V
	Season-HOV interactions		Linear HOV time trend	Non-linear HOV time trend	
Clean Air Sticker Dec 2006 - Feb 2007	0.106** (2.10)	0.129** (2.44)		-0.13 (1.44)	-0.251** (2.35)
Clean Air Sticker March – May 2007	0.171*** (3.59)	0.157*** (3.56)			
Clean Air Sticker June – August 2007	0.313*** (3.70)	0.329*** (3.51)			
Clean Air Sticker Sept – Nov 2007	-0.044 (0.89)	-0.055 (1.10)			
Clean Air Sticker Dec 2007 - Feb 2008	0.065 (1.17)	0.052 (1.05)			
Clean Air Sticker March – May 2008	0.134*** (3.78)	0.141*** (4.02)			
Clean Air Sticker June – August 2008	0.137*** (3.90)	0.140*** (3.82)			
Clean Air Sticker October – Nov 2008	0.096*** (4.68)	0.058** (2.51)			
Clean Air Sticker Dec 08 – Jan 2009	0.070*** (4.00)	0.067*** (3.87)			
Clean Air Sticker Feb - May 2009	0.095*** (5.92)	0.100*** (6.23)			
Clean Air Sticker Intercept or (c/r)			0.131*** (3.31)	0.242*** (3.43)	0.402*** (4.76)
Clean Air Sticker – Linear Time Trend			-0.0004 (1.05)		
r				-0.009*** (3.06)	-0.013*** (5.71)

Evolution of Sticker Value Over Time



Value of Time

- Solve the NPV for a value of time

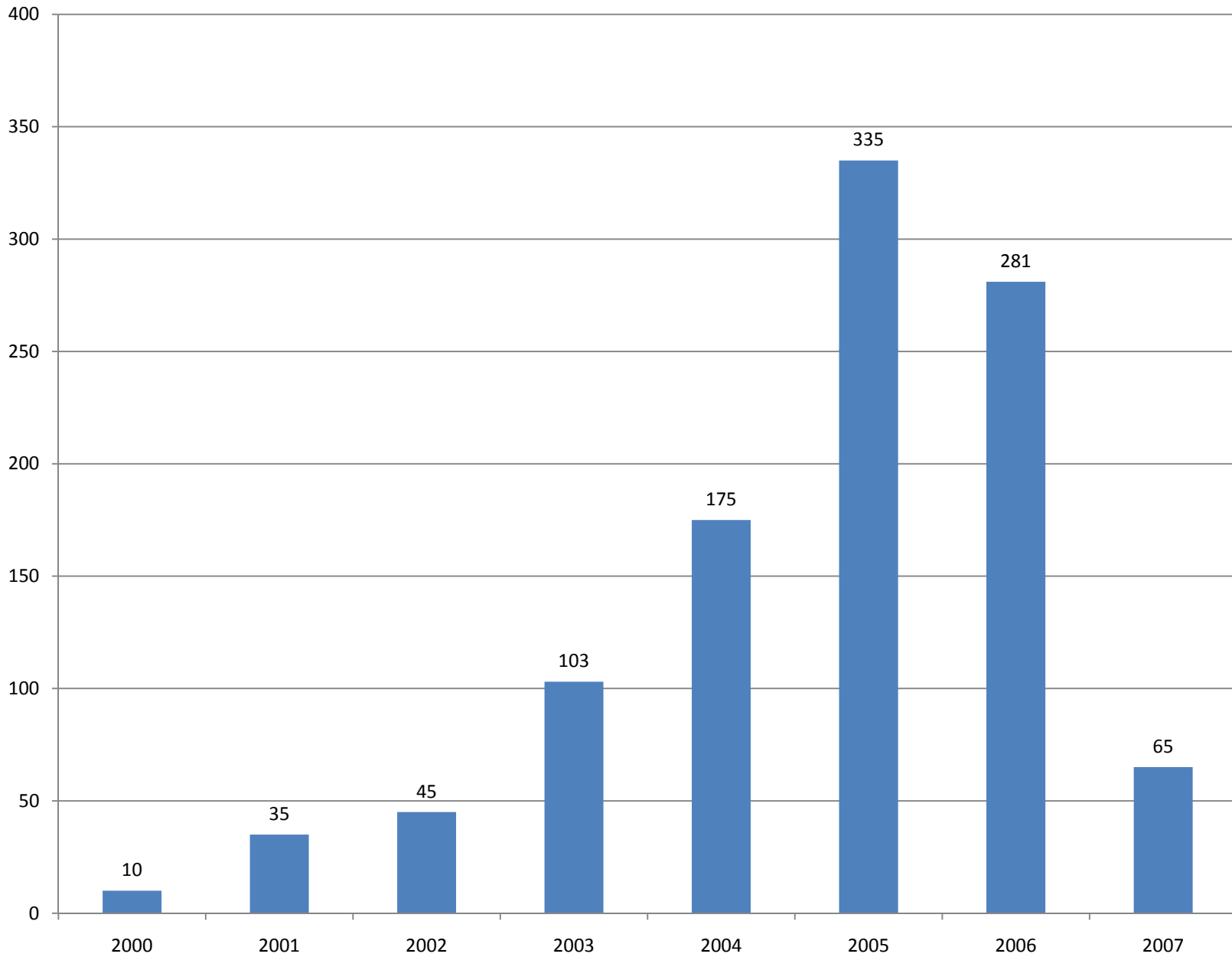
$$WTP(t) = \begin{cases} V_1 & \text{if } t < \text{February 2007} \\ \frac{c}{r}(1 - e^{-r(T-t)}) & \text{if } t \geq \text{February 2007} \end{cases}$$

- Using the results from the regressions gives us values of having the sticker at \$40-94 per week
 - Bay Area time savings of 17 minutes each way (RIDES Associates 2004),
 - Commuters make two trips a day, five days a week
- A Clean Air Sticker values time at \$14-\$33 per hour
 - Similar to the range of
 - \$20-40 per hour found by Brownstone and Small (2005),
 - \$30 median value of time in Steinmetz and Brownstone and Steinmetz (2005)
 - 50 percent of the gross wage rate found in Small (1992).

Implications

- Consumers are rationally pricing these stickers
- Consumers have this value for driving under HOV conditions without having to carpool
- Was this the best way to use the excess capacity?

Cars with HOV Stickers By Model Year

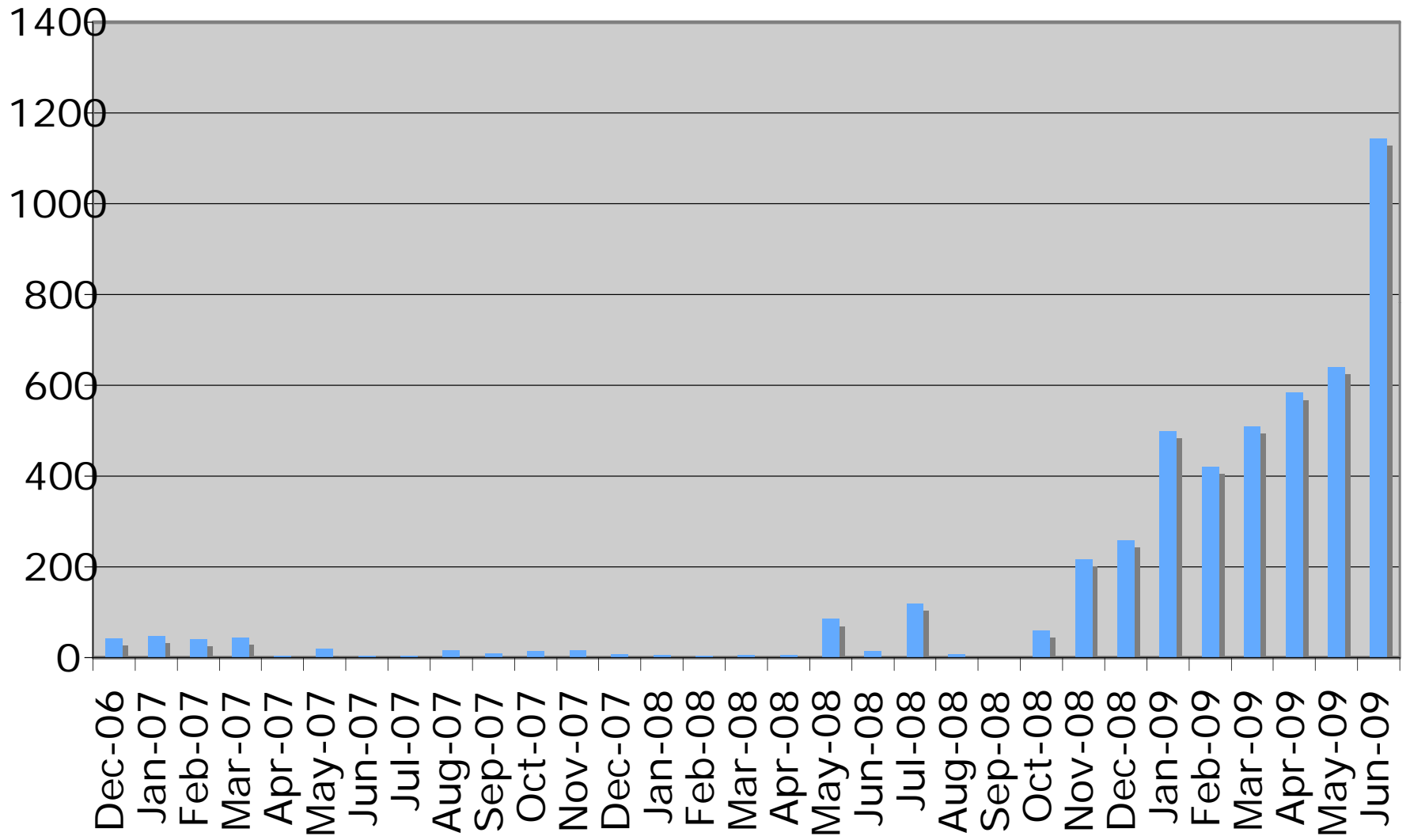


Questions?

Second Best Congestion Pricing

- Give permits only to new hybrids
- Clean Air Stickers are a blunt instrument compared to congestion pricing and direct subsidies for hybrids

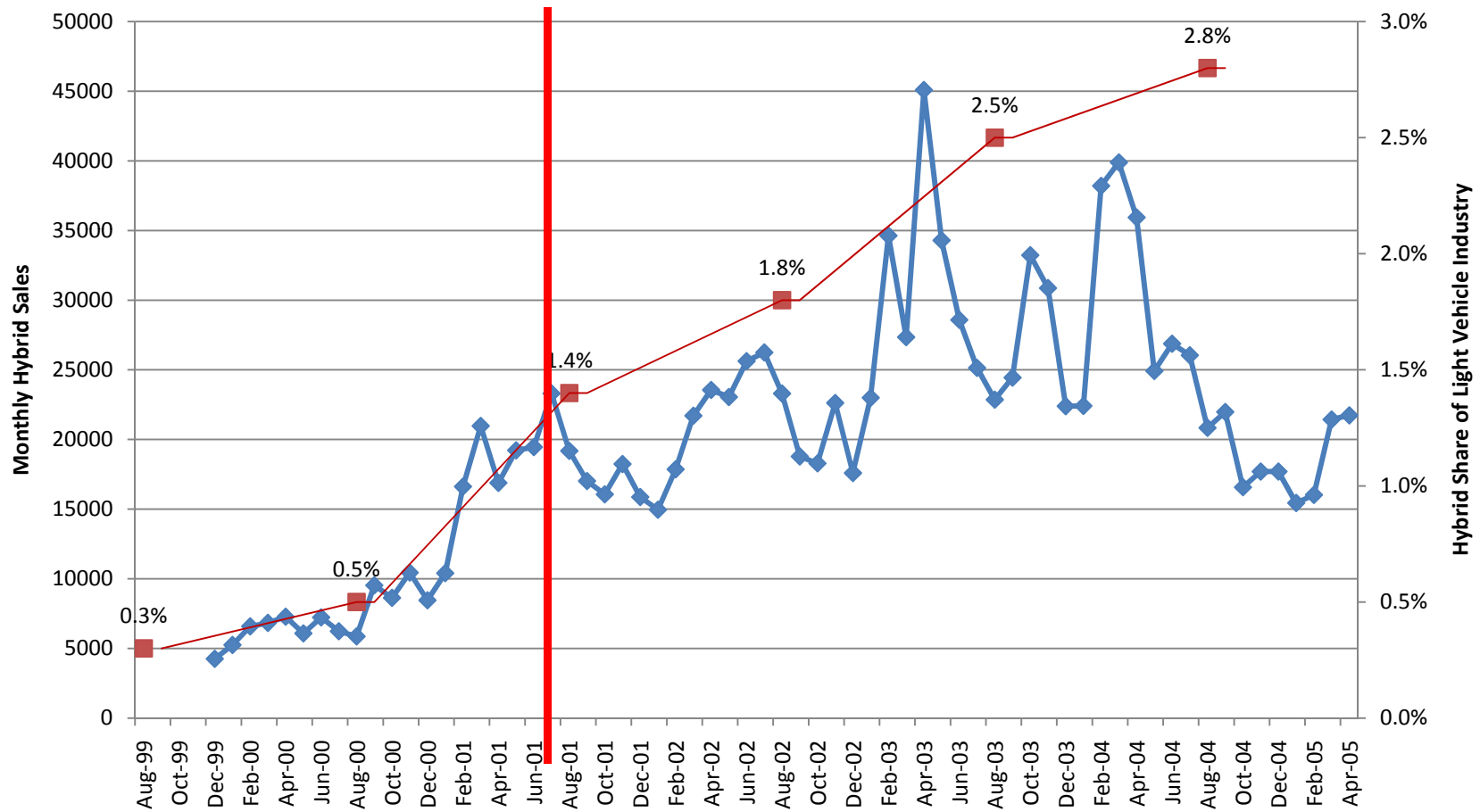
Observations On



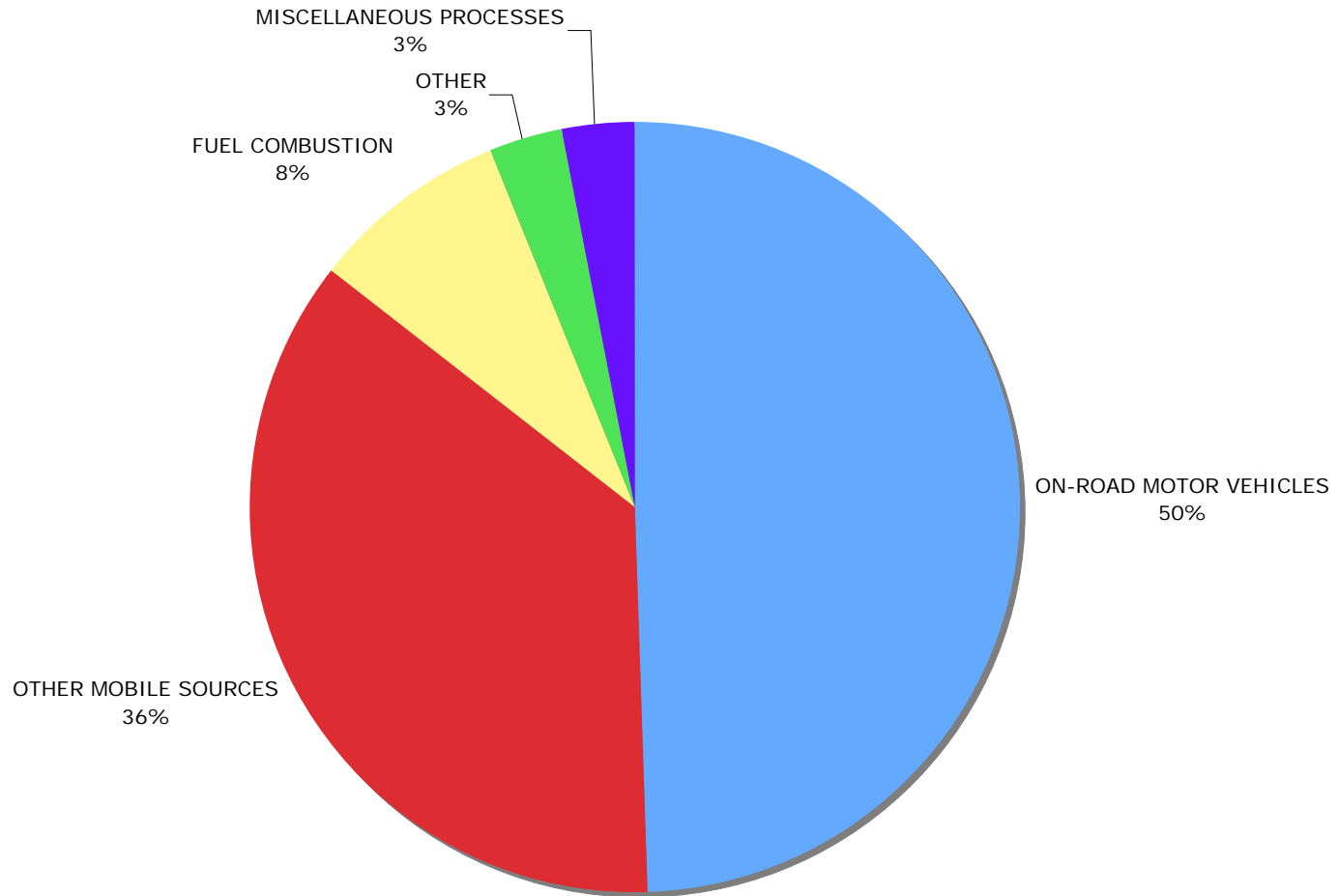
Time

Technology Forcing Benefits

U.S. Sales of Hybrids and Hybrid Share



Sources of NO_x



Sources of ROG (HC)

