



## Potential for Greenhouse Gas Reduction through Economic Incentives that Change Household New Vehicle Purchase Behavior: The California Feebate Project

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**Ryuichi Kitamura: The Inquisitive Scholar and Engaging Partner**

June 29, 2009 – Buehler Center, UC Davis - 2:30 PM - 4:15 PM Session

### Outline

- Z Background on the problem de jour:
  - y Timeline on emissions and energy-related policy issues
  - y Greenhouse Gas (GHG) Emissions in California
  - y “California Feebate Research Project”
  
- Z But,
  - y This topic is merely an “excuse”
  - y We start in the present, and work backward (then forward?)
  - y “The Curious Case of Benjamin Bunch’s (Dad)”
  - y (as it relates to the legacy of Ryuichi Kitamura)

### Review of Recent Events

- Z **Tuesday May 19, 2009**
  - y President Obama sets historic fuel efficiency and emissions standards
    - x For the first time, CO<sub>2</sub> emissions placed under federal control
    - x Reduction = 900 million metric tons, 30% decrease by 2016
    - x (And/or?) 30% reduction in new vehicle fleet fuel economy (35.5 mpg) = most aggressive increase in U.S. history
- Z **April 2009**
  - y EPA confirmed that CO<sub>2</sub> emissions pose a threat to human health and welfare and should be regulated by federal law.
- Z **March 2009**
  - y NHTSA raised fuel efficiency standards for cars to 30.2 mpg and to 27.3 mpg for minivans, SUV’s and light trucks.
- Z **January 2009**
  - y President Obama orders EPA to review decision on California waiver

### Review of Events (some not so recent) –cont-

- Z How did we get here? [Let’s go the other direction...]
  
- Z **1975**
  - y Congress gives National Highway Transportation Safety Administration (NHTSA) authority to set vehicle mileage standards.
- Z **1990’s**
  - y California Air Resources Board periodically issues and updates (“fuel neutral”) mandates requiring cleaner new vehicles.
- Z **2002**
  - y California enacts its own law (Pavley) regulating CO<sub>2</sub> emissions.
- Z **2004**
  - y Automakers sue California in federal court, claiming Pavley = fuel economy standards, not an emissions regulation.

## Review of Events (more recent again) –cont-



- z 2006
  - y California passes **Global Warming Solutions Act (AB 32)**. Requires GHG emissions to return to 1990 levels by 2020. If “no Pavley,” requires **alternative regulatory options** to achieve same reductions.
- z April 2007
  - y US Supreme Court declares CO<sub>2</sub> a pollutant under the Clean Air Act and should thus be regulated by the EPA
- z December 2007
  - y Congress passes the Energy Independence and Security Act
    - x Requires fuel economy increase to at least 35 mpg by 2020
    - x => Reduction in CO<sub>2</sub> emissions of at least 30 percent by 2020.
  - y EPA denies California waiver. California and 17 other states file suit.
- z September 2008
  - y California Air Resources Board solicits research proposals on **Feebates**

## The Feebate Concept

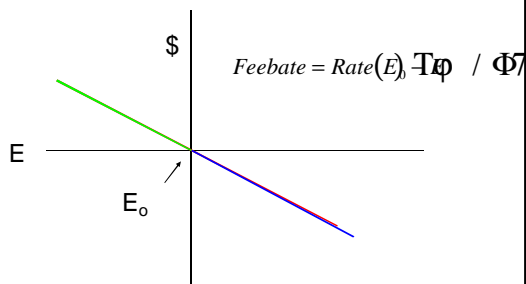


- z A fiscal policy combining
  - y A **FEE** on inefficient vehicles
  - y A **reBATE** on efficient vehicles.
- z (In)efficiency **measure** = Emissions per mile
- z A **benchmark** defines who pays and who receives. (distribution/equity)
- z A **rate** determines the marginal costs and benefits. (efficient solution)
- z A **functional form** determines payment amount
- z There are also important options for:
  - y **Implementation** strategies
  - y **Locus** of monetary transaction

## Simplest Feebate



Simplest feebate is **linear** in GHG emissions per mile. Here, **benchmark** is origin, rate, **R**, is slope of the line. System is **revenue neutral** if right benchmark chosen.



## Options for Functional Forms

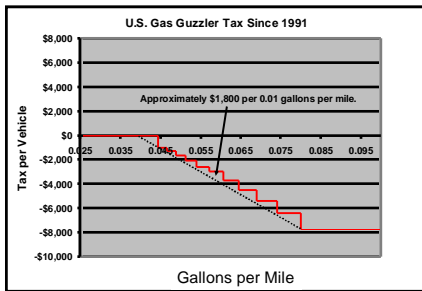


- z Most obvious are: **straight line** and **step functions**.
- z Straight lines:
  - y Value every g of CO<sub>2</sub> mitigated equally.
- z Step functions:
  - y Contain discontinuities that can lead to inefficient responses.
  - y The French government considered step functions easier for consumers to understand.
  - y The U.S. gas guzzler tax, French Bonus/Malus and Canadian feebate systems were all step functions.

## U.S. Gas Guzzler Tax



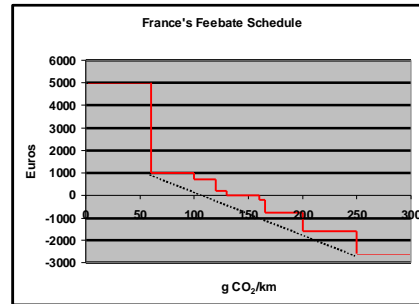
= Half a feebate system.  
Is a step function rather than a straight line.  
R is approx \$1,800/0.01 gal/mi (= \$20/g/mi)



## France's bonus/malus feebate



It is also a step function.  
R \$16.50 per g/mi (\$1,500 per 0.01 gal/mi).



## Options for Benchmarks

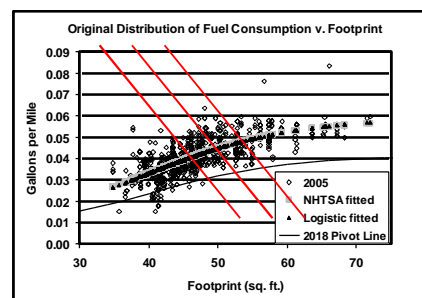


- Z One benchmark for all vehicle types
- Z Two benchmarks:
  - y Passenger Cars
  - y Light duty trucks
- Z Vehicle-class based benchmarks
  - y Eg. Small car, Midsize Car, Large Car, Small SUV, Midsize SUV, Large SUV, Small Pickup, Large Pickup, etc.
- Z Benchmarks based on vehicle footprint
  - x [Similar to recent developments for CAFÉ standards]

## Multiple Benchmark Systems



Feebate benchmarks could be vehicle class-specific or could even be a function of footprint, like the new CAFÉ footprint standard.



## Options for Rates



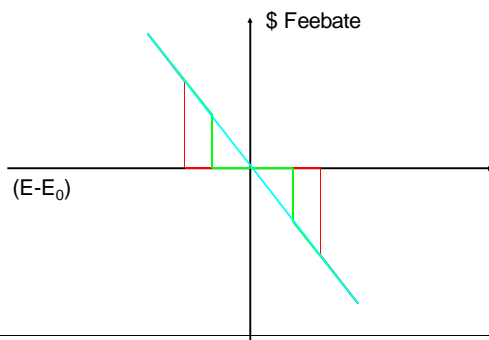
- z We\* are currently considering a range of \$10-\$30 per g/mi.
- z Replacement of Pavley will require allowing the feebate rate to be determined by the need to reduce emissions.
- z Feebate rates higher than a cap-and-trade  $C$  price can be justified:
  - y Correct market imperfection
  - y Reduce oil dependence
  
- z \*Should not imply any current decisions by CARB.

## Additional Issues



- z **Implementation options**
  - y Immediate implementation
  - y 2-year delay
  - y Phase-in by increasing slope
  - y Phase in by transition from net subsidy to revenue neutrality
  - y Phase in by closing "doughnut hole" (next slide)
- z **"Locus of monetary transaction" options**
  - y State-to-manufacturer
  - y Dealer-to-customer
  - y State-to-customer

## What is a closing doughnut hole?



## Recent 'Lessons Learned'



- z France's **bonus/malus system** has already had a large effect on vehicle sales.
- z Meeting with M. Boccon-Gibod, French Ministry of Finance.
- z **In 2007:**
  - y 30% of passenger cars sold in France had emissions rates < 130 g/km.
  - y 45% were in the range 130-160 g/km.
  - y 25% emitted more than 160 g/km.
- z **In 2008:**
  - y 43% emitted < 130 g/km.
  - y 42% emitted between 130-160 g/km.
  - y 15% emitted more than 160 g/km.

## The UC Feebate Study: Overview



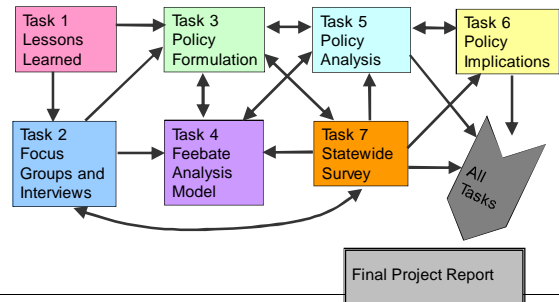
### Z Research Purpose

- y The UC Feebates study for the California Air Resources Board will comprehensively support decision-making about feebates.

### Z Research Tasks/Methodologies

- y Lessons learned (France, Canada, etc.)
- y Focus groups, dealer and manufacturer interviews
- y Policy formulation (with formal public input)
- y California Feebate Analysis Model
- y Policy Analysis
- y Assessment of Policy Impacts
- y Statewide survey of consumers

## Task Overview



## Task 4: Feebate Analysis Model Development



### Z Manufacturer Decision Model

- y Produce vehicle offerings by manufacturer, attributes and technology status for 2009-2020
  - x Factor in design cycles, future product plans
- y New vehicle market regions: CA-only, CA + Pavley States, and Rest of US

### Z Vehicle Market Simulation Model

- y Incorporate new vehicle attributes with consumer preferences and used vehicle stock to project fleet composition for 2009-2020

## Task 4: Feebate Analysis Model Outputs



- Z New passenger vehicle GHG emission rates by vehicle class and manufacturer
- Z Annual and cumulative GHG emissions from all passenger vehicles
- Z Passenger vehicle sales by model year
- Z Manufacturer sales revenues by model year
- Z Impacts on used vehicle prices and transactions
- Z Fee and rebate flows, net State revenue

## Pre-Kitamura Legacy



- z How did "Benjamin Bunch's (Dad)" find himself modeling California vehicle market response to environmental policies?
- z When I started:
  - y Finished PhD dissertation at Rice in late 1984
  - y Thesis: "Parameter Estimation of Probabilistic Choice Models"
  - y Assistant Professor, UCD Graduate School of Administration
    - x Visiting 1984-1985, Hired 1985
- z First few papers from thesis on **discrete choice models**:
  - y Models: Multinomial Logit, Elimination by Aspects, "Batsell-Polking"
  - y Data sets:
    - x Choice of Snacks (cakes and/or candy bars) from a vending machine by a guy named "Jack"
    - x Choice of Political Candidates in 1980 US presidential primaries
  - x Simulated data

## UC Davis in late 1980's



- z My environment in UCD Graduate School of Administration
  - y One visiting professor in marketing (not me)
  - y Economists, statisticians, finance/accounting, organizational behavior
- z "A guy over in Civil Engineering"
  - y ECI 254 "**Discrete Choice Analysis of Travel Demand**"
- z We started working together
  - y He provided:
    - x Problems (Household vehicle ownership)
    - x Data (Dutch mobility panel)
    - x Mentorship

## The Beginning of (my portion) of the Legacy



- z Bunch and Kitamura (?-1990)
  - y "**Multinomial Probit Model Estimation Revisited: Testing Estimable Model Specifications, Maximum Likelihood Algorithms, and Probit Integral Approximations for Trinomial Models of Household Car Ownership.**" Transportation Research Group Research Report UCD-TRG-RR-4 (April 1990).
    - x My first serious exposure to Roy's Identity
    - x Presentation @ 1988 ORSA/TIMS -> Hani Mahmassani
    - x This led to: "**Estimability in the Multinomial Probit Model.**" Transportation Research B, 1991, Vol 25B(1), pp. 1-12. ]
- z Kitamura and Bunch (?-1990)
  - y "**Heterogeneity and State Dependence in Household Car Ownership: A Panel Analysis Using Ordered-Response Probit Models with Error Components.**" 11th International Symposium on Transportation and Traffic Theory, Elsevier, July 1990.

## Mentorship



- z From: SMTP%"KITAMURA@poppy.UCDAVIS.EDU" 16-JUN-1989 12:30
- z To: SMTP%"<@ucdavis.ucdavis.edu:dsbunch@ucdavis.bitnet>"
- z Subj: Submittal letter
- z Date: Fri, 16 Jun 89 12:09:15 PDT
- z From: KITAMURA@poppy.UCDAVIS.EDU
- z Subject: Submittal letter
- z To: <@ucdavis.ucdavis.edu:dsbunch@ucdavis.bitnet>
- z David: The letter to Frank Haight might look like this:
  
- z Dr. Frank A. Haight, Editor-in-Chief
- z Transportation Research
- z Institute of Transportation Studies
- z University of California, Irvine
- z Irvine, CA 92717
  
- z Dear Dr. Haight:
  
- z Enclosed please find three copies of the manuscript entitled
- z "Multinomial probit ..." written by D.S. Bunch and R. Kitamura. We
- z would like to submit the manuscript for consideration for publication in
- z Transportation Research Series B. As we discussed earlier, we have
- z funds available for page charge for the publication of this paper.
- z Should you have any question regarding the manuscript, please do not
- z hesitate to call Bunch at (916)752-2248 or Kitamura at (916)752-7435.

## The Legacy Continues



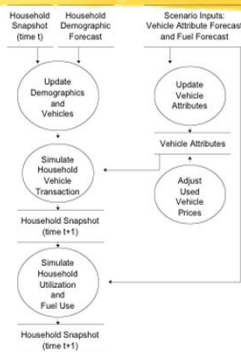
- Z Recall:
  - y 1990's California Air Resources Board periodically issues and updates ("fuel neutral") mandates requiring cleaner new vehicles.
- Z What came next:
  - y First (for me) "big" funded project [California Energy Commission]
  - y Clean Fuel Vehicles in California (SP Pilot Project)
    - x = Kitamura + Tom Golob + David Bunch + Mark Bradley
    - x A chance to apply stated preference to an important topic
    - x First hands-on exposure to nested logit models
- Z Result:
  - Z "Demand for Clean-Fuel Vehicles in California: A Discrete-Choice Stated Preference Survey" Transportation Research A, Vol. 27A, No. 3, pp. 237-253, 1993.

## We were just getting warmed up...



- Z Multi-year project on AltFuel Vehicle Demand
  - y Funded by Southern California Edison, PG&E, Energy Commission
  - y Panel data collection
    - x Observation of demographic changes and
    - x Vehicle transactions
  - y Stated intentions on vehicle transactions
  - y Stated choice experiments on Alternative Fuel Vehicle options
    - x Battery powered EV
    - x "Alcohol"
    - x Compressed natural gas

## A Frequently Used Slide: Market Simulation



## Project Milestone: Laguna Beach



- Z Laguna Beach Conference
  - y November 4-5, 1993
    - x Brownstone, Bunch, Golob, Kitamura, Bradley
- Z All the bases were covered:
  - y Overall modeling approach (previous slide)
  - y Stated preference models for AFVs
  - y Revealed preference on vehicle ownership & use
- Z Emphasis: Value of Panel Data in Forecasting

## Ryuichi on the Importance of Panel Data



- ✗ Please follow this link to view this video:
- ✗ [http://www.youtube.com/watch?v=1Z7qHg\\_rEQ](http://www.youtube.com/watch?v=1Z7qHg_rEQ)

## The Legacy Continues



- Z 2002 - 2004
  - y ITS/SCE Vehicle Market Microsimulation Model is reborn as CARBITS to support analysis in development of Pavely Regulation
- Z 2004-2008
  - y CARBITS model is updated
- Z NOW
  - y California Febate Research Project

## Partial View of What the Legacy Means to Me

