

# Demand for Fuel Economy in the Indian Car Market

WEAI Meetings

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# Motivation for the Paper

- Debate in India regarding vehicle fuel economy standards
  - No current CAFE standards
  - Recent requirement to post MPG on price sticker
  - Should India institute CAFE standards?
- Main economic rationale for CAFE is failure of auto market to produce efficient fuel economy
  - Consumers are myopic
  - Producers are oligopolistic

# Questions We Address

- What is the cost to Indian consumers of purchasing a more fuel-efficient vehicle?
  - Can buy a diesel car rather than a petrol car
    - Diesel cars get more MPG and diesel 30% cheaper than petrol
  - Can buy a more fuel efficient petrol car
- Do Indian consumers consider vehicle fuel economy when purchasing new vehicles?
- How does the cost to them of purchasing a more fuel-efficient vehicle compare to the fuel savings?

# Approach I: Diesel/Petrol Choice

## If people are rational:

- For petrol vehicle buyers:

Fuel savings from buying a diesel vehicle  $<$  additional cost of a diesel vehicle

- For diesel vehicle buyers:

Additional fuel cost of a petrol vehicle  $>$  lower purchase price of a petrol vehicle

# Choice Between Diesel/Petrol Cars

- Car buyers receive utility from:
  - Vehicle characteristics  $Z$  (weight, horsepower)
  - Miles driven ( $K$ )
- Choose  $Z$ ,  $K$  and  $d=1$  (diesel) or  $= 0$  (petrol)

Maximize  $U(Z,K)$  subject to

$$Y = P(Z,d) + K [dp_d + (1-d)p_p]/kpl(Z,d)$$

- Buy petrol if  $U(Z_p^*, K_p^*) > U(Z_d^*, K_d^*)$

# Irrationality in Fuel Type Choice

- Petrol car buyer is irrational if:
  - Cost of his chosen bundle would be cheaper as a diesel:

$$P(Z_p^*, 0) + K_p^* [p_p / kpl(Z_p^*, 0)] > P(Z_p^*, 1) + K_p^* [p_d / kpl(Z_p^*, 1)]$$

- A similar statement can be made for diesel car buyers.
- Requires predicting  $P(Z, d)$  and  $kpl(Z, d)$

# Approach II: Hedonic Price Function for Petrol Cars

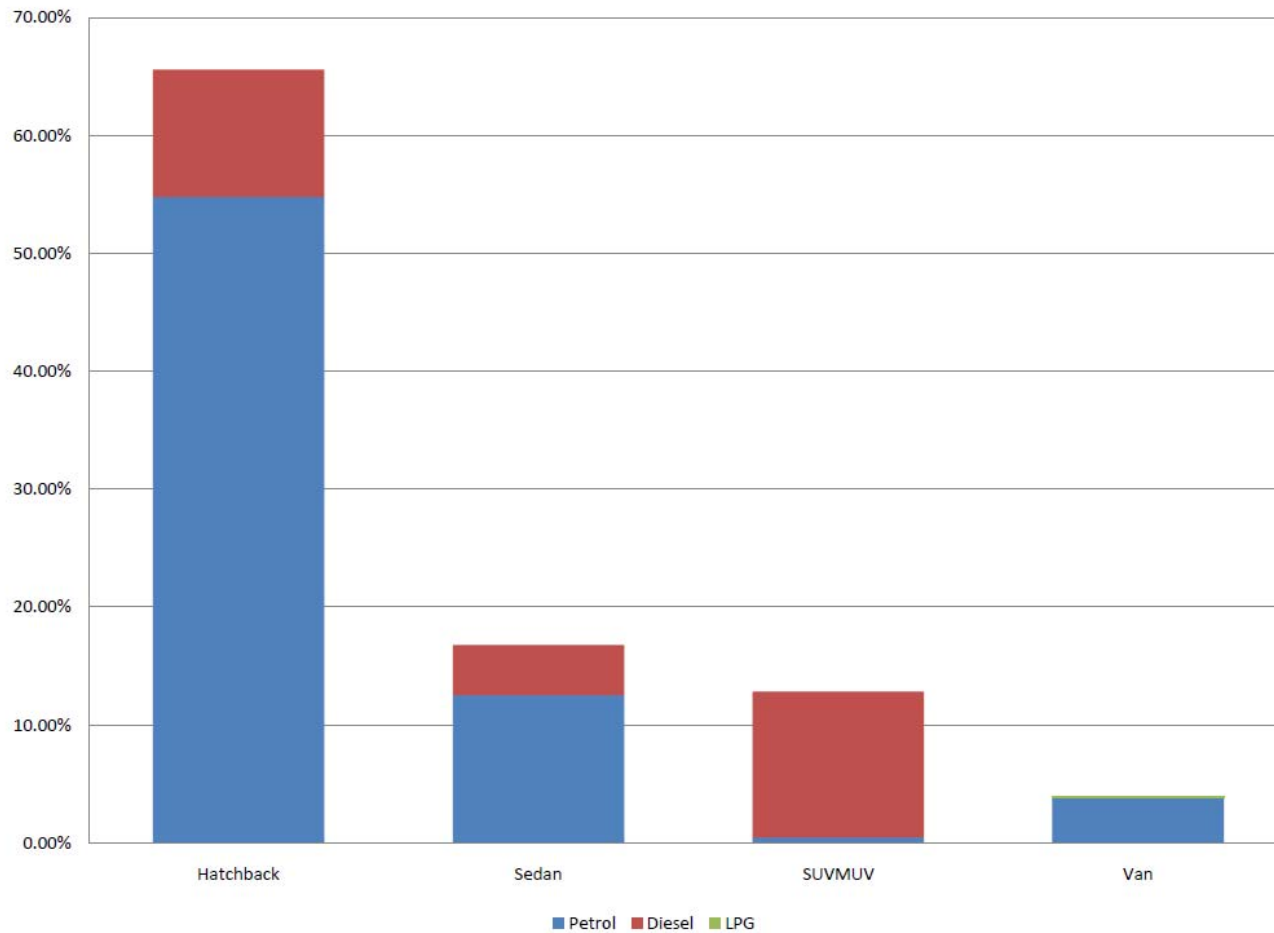
- Estimate an hedonic price function for petrol cars with kilometers per liter (kpl) as a vehicle characteristic
  - Calculate the cost to consumers of additional kpl
  - Compare marginal cost with present discounted value of fuel savings
- We do this for petrol hatchbacks and petrol sedans, which constitute 80% of each market

# Overview of Indian Car Market

- Approximately 150,000 passenger vehicle sold each month
- Market is very concentrated:
  - Maruti 45% of sales
  - Tata 16%; Hyundai 13%; Mahindra & Mahindra 7%
- Fuel is expensive: petrol almost \$5 per gallon; diesel over \$3 per gallon
- Next slide shows breakdown of sales by vehicle and fuel type, based on 2003-2006 data from J.D. Power



# Market Shares by Body and Fuel Type



# Characteristics of 2006 Petrol Cars

	Hatchback	Sedan	US Car
Weight (pounds)	1,800	2,300	3,500
Horsepower to Weight (in lbs.)	0.032	0.041	0.054
Miles per gallon (City)	28.3	22.3	19.4

# Markets for Hatchbacks and Sedans

- Markets are segmented by price
  - Avg. cost of petrol hatchback = 400,000 Rs.
  - Avg. cost of petrol sedan = 900,000 Rs.
- Monthly kilometers driven:
  - Hatchbacks: 1100 km petrol; 1900 km diesel
  - Sedans: 1300 km petrol; 1900 km diesel
- Do separate analyses for hatchbacks, sedans

# Models Estimated

All models estimated using data from AutoCar India, 2003-2008 model years:

- Hedonic price functions for hatchbacks, sedans including diesel as a vehicle characteristic
- Fuel economy frontiers for hatchbacks and sedans, including diesel as a vehicle characteristic
- Hedonic price functions for petrol hatchbacks, sedans including fuel economy as a vehicle characteristic

# Model Specification-Fuel Choice

- Dependent variables:
  - Log(Delhi Vehicle Price in 2008 Rs.)
  - Log(City kilometers per liter)
- Explanatory variables:
  - Vehicle weight
  - Ratio of horsepower to weight
  - Luxury index
  - Safety index
  - Automatic transmission
  - Year dummies
  - Diesel dummy

# Diesel/Petrol Choice: Hatchbacks

- New car price premium for diesel 17.4%
- Fuel economy about 16.8% greater for diesel
  - But recall that diesel also 30% cheaper per liter
- Using a discount rate of 12% (rate on auto loans)
  - Petrol hatchback owner better off with a diesel for horizons  $> 5$  years
  - Diesel hatchback owner better off with a diesel for horizons  $> 2$  years

# Diesel/Petrol Choice: Sedans

- New car price premium for diesel 17.5%
- Fuel economy about 28.3% greater for diesel
  - But recall that diesel also 30% cheaper per liter
- Using a discount rate of 12% (rate on auto loans)
  - Petrol sedan owner better off with a diesel for horizons  $> 7$  years
  - Diesel sedan owner better off with a diesel for horizons  $> 4$  years

# What Is the Cost of a More Fuel-Efficient Petrol Vehicle?

- Hedonic price functions estimated for petrol hatchbacks and sedans; kpl replaces diesel dummy
- In the petrol hatchback market additional fuel economy has a zero price
- In the petrol sedan market 1 additional kpl raises vehicle cost by 7.3%
- Additional fuel economy is fully priced in the petrol sedan market: payback period is about 9 years



# Conclusions

- Owners of diesel cars clearly rational:
  - Cheaper cost of a petrol vehicle is overtaken by increased fuel costs in a short period ( 2-4 years)
- Owners of petrol cars might be better off switching to diesel, assuming price differential persists
  - But payback period 5-7 years at relevant interest rates
- Additional fuel economy is fully priced in the petrol sedan market: payback period is about 9 years

# 12% Discounted Break Even Period (Fuel Type)

	2003	2004	2005	2006
petrol hatchback	5.6	6.4	4.6	4.3
diesel hatchback	2.9	2.1	2.2	2.0
petrol sedan	6.6	7.7	7.2	5.7
diesel sedan	5.1	3.2	3.2	3.7

# 0% Discounted Break Even Period (Fuel Economy)

	2003	2004	2005	2006
petrol sedan	9.8	9.5	8.5	7.2