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# Valuation of Fuel Flexibility in a Vehicle Fleet

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# Design Parameters

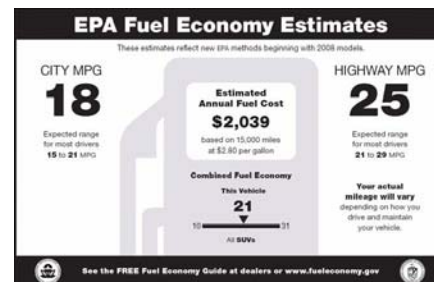
- Fuel Type

[http://www.ecologics.ie/wp-content/uploads/oil\\_derrick.jpg](http://www.ecologics.ie/wp-content/uploads/oil_derrick.jpg)



<http://www.starchildscience.org/images/chapter-images/chapter5/ethanol.jpg>

- Fuel Economy



[http://www.epa.gov/fueleconomy/420f06069\\_image002.jpg](http://www.epa.gov/fueleconomy/420f06069_image002.jpg)

- Patterns of Use

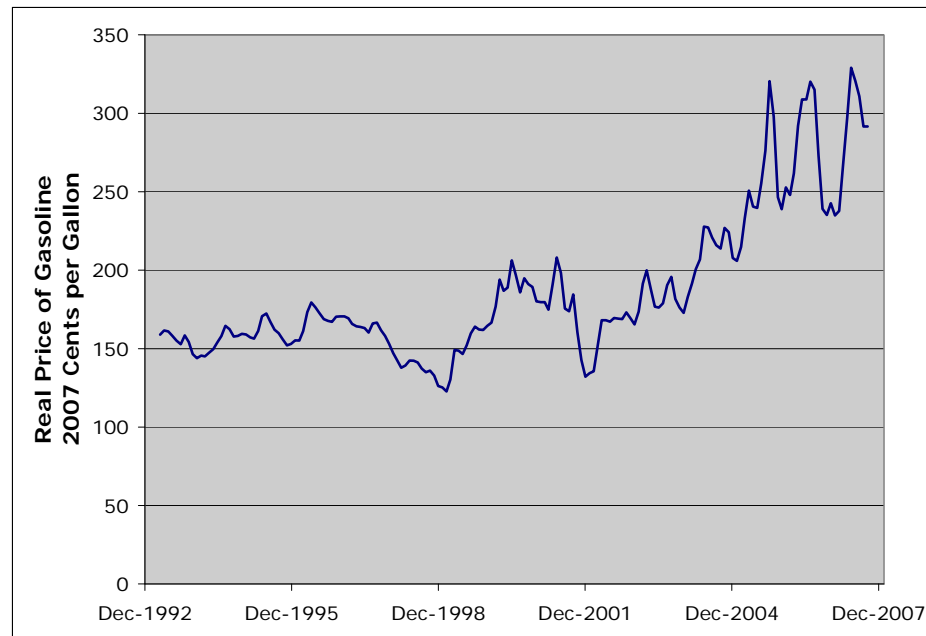


[http://www.theblackadder.co.uk/2005/Queenstown/tn\\_Final%20ometer.jpg](http://www.theblackadder.co.uk/2005/Queenstown/tn_Final%20ometer.jpg)

# Sources of Uncertainty

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- **Gasoline Price**

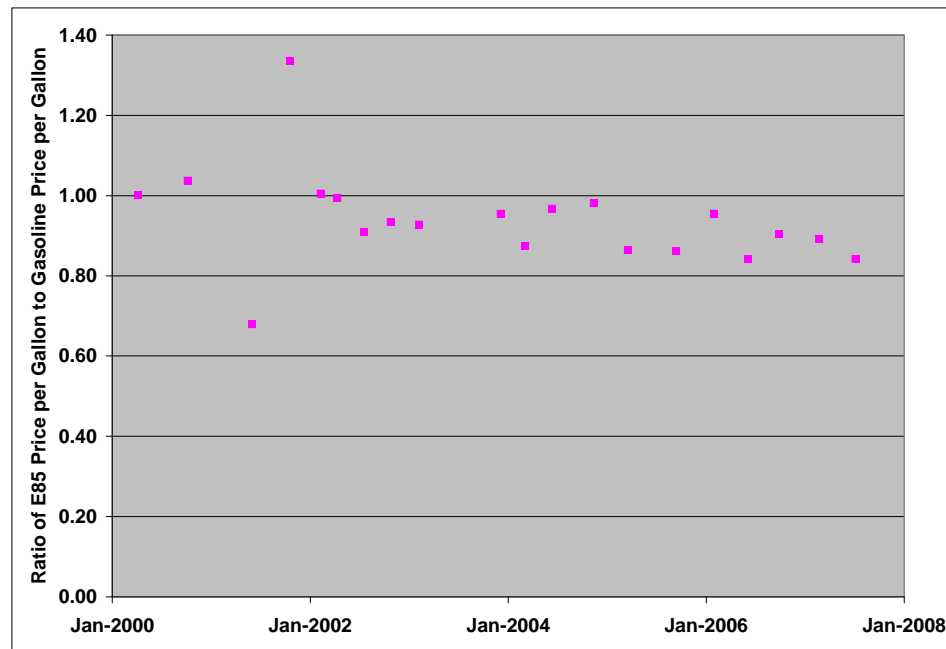


Monthly Average Gasoline Prices, 1993 – Present (United States Department of Energy, Energy Information Administration, 2007a)



# Sources of Uncertainty

- E85 Price



E85 been 85-95% of gasoline price since 2002. (United States Department of Energy, Office of Energy Efficiency and Renewable Energy, 2007b)



# System Concepts

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$$Cost = (VMT / MPG) \times P_{Fuel}$$

**Hyundai Elantra**

**\$13,525**

**28 mpg**



[www.hyundaiusa.com](http://www.hyundaiusa.com)

**Chrysler Sebring (Gasoline)**

**\$21,930**

**24 mpg**



[www.chrysler.com](http://www.chrysler.com)

**Chrysler Sebring (Flex)**

**\$23,280**

**22 mpg (gas) 16 mpg (E85)**



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# Decision Analysis

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- **Gasoline Prices**

	Stage 1 Prices		Stage 2 Average Prices		
	Average	End	Low	Mid	High
Stage 1 Low	\$2.04	\$1.84	\$1.65	\$1.75	\$1.86
Stage 1 Mid	\$2.31	\$2.10	\$1.86	\$1.99	\$2.10
Stage 1 High	\$2.54	\$2.28	\$2.09	\$2.26	\$2.35

- **Ethanol Prices**

$$\text{High} = 95\% \times P_{\text{gasoline}}$$

$$\text{Low} = 85\% \times P_{\text{gasoline}} - \$0.10$$



# Decision Analysis Results

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- **Expected Costs**

- **Elantra = \$19,654**



[www.hyundaiusa.com](http://www.hyundaiusa.com)

- **Sebring (gasoline) = \$29,081**

- **Sebring (flex) = \$31,081**

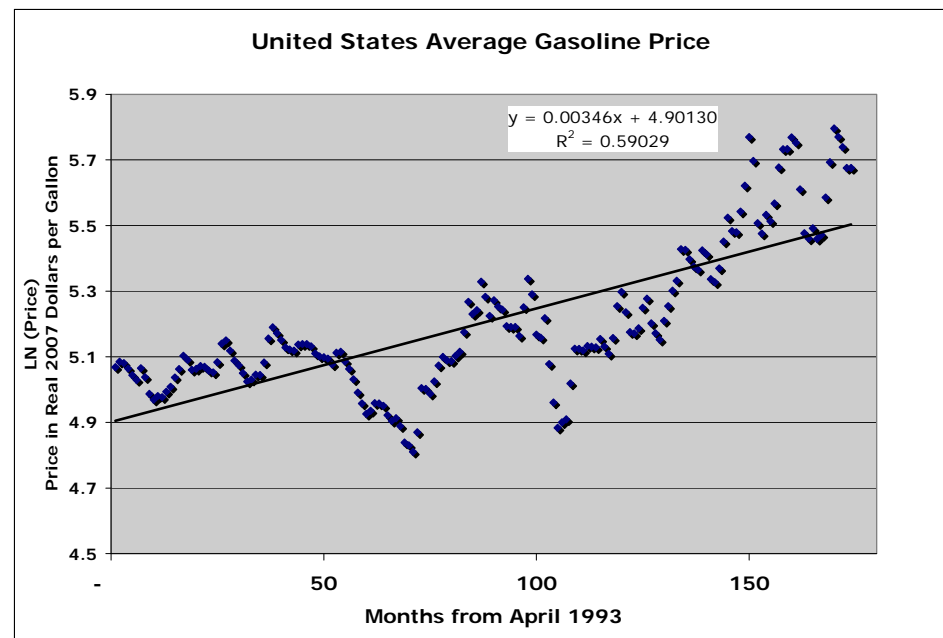


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# Lattice Analysis

- Gas Price Lattice Model
  - Geometric Brownian Motion



Monthly average gasoline prices are volatile (relative volatility = 10%), and have increased at an average of 0.35% per month since April, 1993. (United States Department of Energy, Energy Information Administration 2007b)

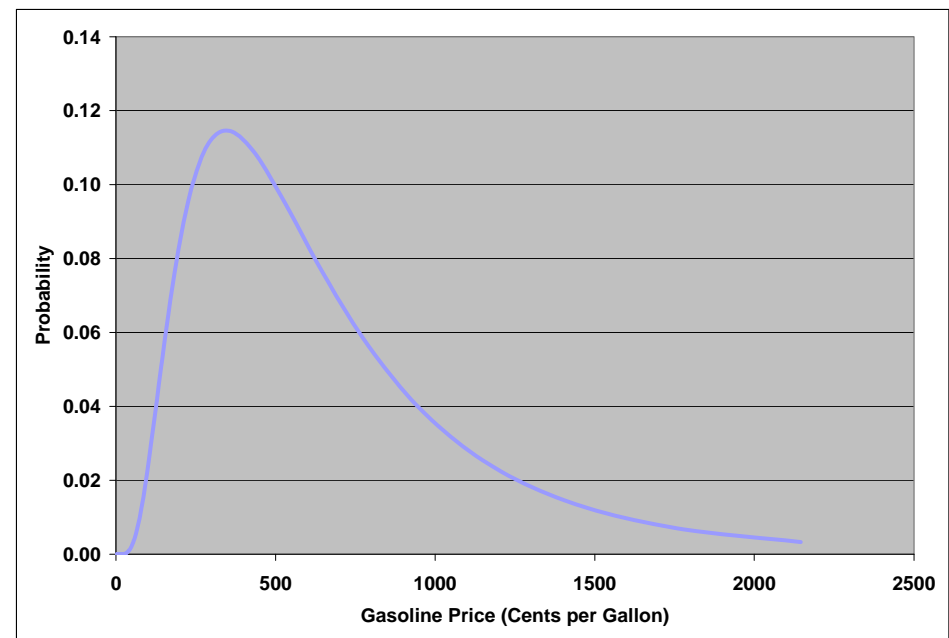




# Lattice Analysis

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- **Lattice Model Results**
  - **Median Gas Price (4 years away)**
  - **\$3.13 / gallon**



Probability distribution of gasoline price after 4 years indicates median estimate of \$3.13 per gallon



# Lattice Analysis

- Assume option to purchase E85 at \$2.45/gallon
- When is it worthwhile to switch?

## Fueling Decisions over 12 month horizon:

Fuel Expenditure for Flexible Vehicle with Option to Switch to Ethanol												
0	1	2	3	4	5	6	7	8	9	10	11	12
\$ 2,489	\$ 2,689	\$ 2,610	\$ 2,450	\$ 2,215	\$ 1,978	\$ 1,739	\$ 1,497	\$ 1,254	\$ 1,008	\$ 759	\$ 509	\$ 256
	\$ 2,323	\$ 2,316	\$ 2,268	\$ 2,163	\$ 1,978	\$ 1,739	\$ 1,497	\$ 1,254	\$ 1,008	\$ 759	\$ 509	\$ 256
		\$ 1,957	\$ 1,952	\$ 1,916	\$ 1,839	\$ 1,706	\$ 1,497	\$ 1,254	\$ 1,008	\$ 759	\$ 509	\$ 256
			\$ 1,624	\$ 1,610	\$ 1,574	\$ 1,506	\$ 1,399	\$ 1,239	\$ 1,008	\$ 759	\$ 509	\$ 256
				\$ 1,327	\$ 1,303	\$ 1,258	\$ 1,189	\$ 1,088	\$ 948	\$ 759	\$ 509	\$ 256
					\$ 1,069	\$ 1,034	\$ 980	\$ 902	\$ 797	\$ 658	\$ 481	\$ 256
						\$ 847	\$ 803	\$ 740	\$ 654	\$ 542	\$ 400	\$ 221
							\$ 658	\$ 606	\$ 536	\$ 444	\$ 327	\$ 181
								\$ 496	\$ 439	\$ 364	\$ 268	\$ 148
									\$ 359	\$ 298	\$ 220	\$ 121
										\$ 244	\$ 180	\$ 99
											\$ 147	\$ 81
												\$ 67



# Lattice Analysis Results

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- Value of flexibility over 4 years
- Sebring FFV vs. Elantra: **(\$290)**
- Sebring FFV vs Sebring: **\$1,064**

Less than price difference – bad deal!



[www.hyundaiusa.com](http://www.hyundaiusa.com)

- Pure value of flexibility: **\$1,926**
  - Theoretical only, no vehicle on market



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# Conclusions

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- **Fuel flexibility adds value for fleet operators**
- **Choosing a high-efficiency vehicle is more important**
- **Increase in purchase price exceeds value of flexibility (for current midsize car options)**
- **Fuel flexibility could add \$2000 value per vehicle if MPG were the same**
- **Costs ~\$100 to add FFV capability, would be worth paying this**

