Presentation to EPA – MSTRS
Washington, DC
September 17, 2008

Automotive Technology, Fuel Efficiency, and The Market

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Market Complexity

Government

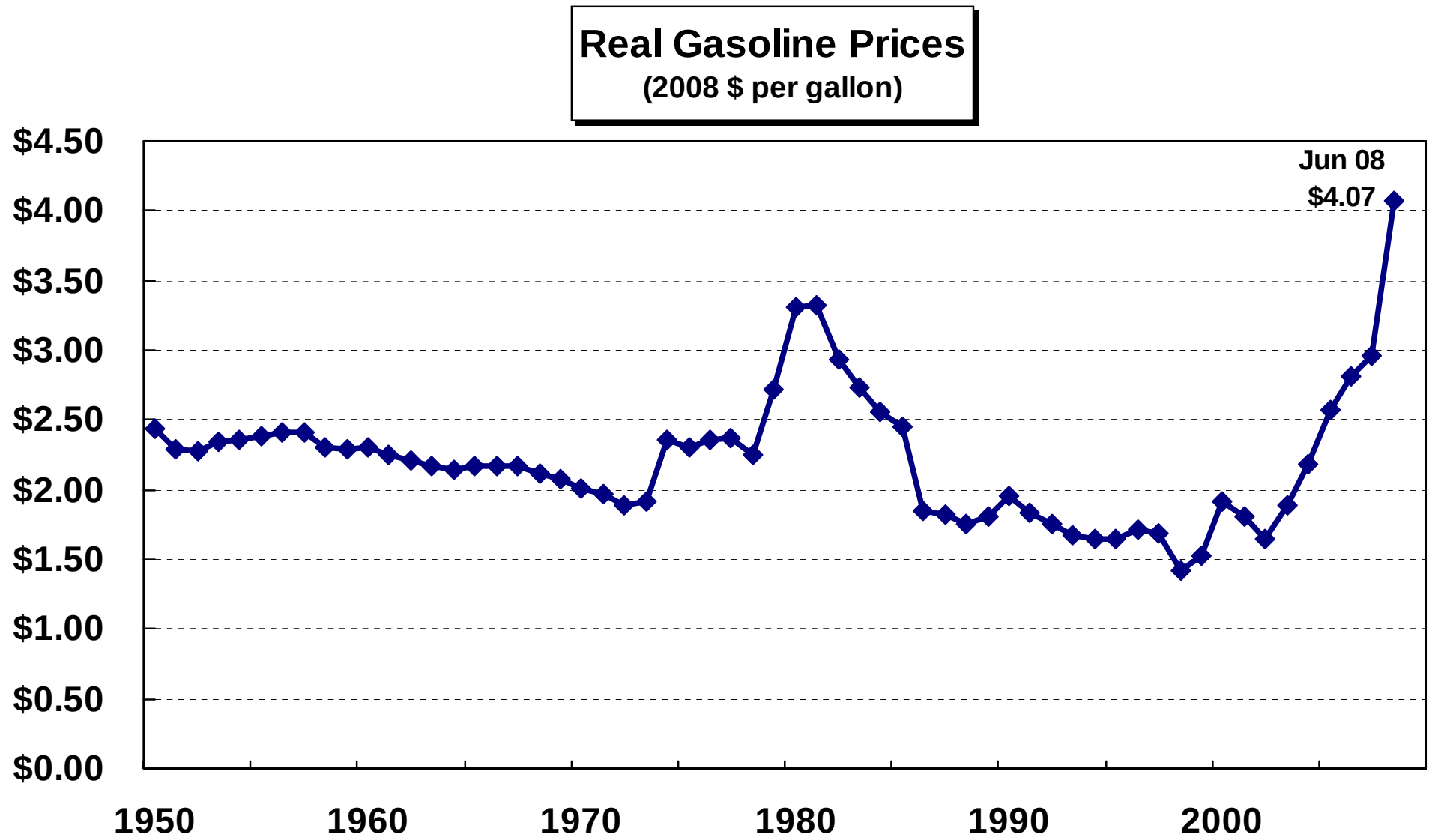
- National vs. State/Regional policy
  - Mandates (Technology Selection)
  - Technology Neutral (Stringency)
- Incentive Funding
- R&D Stimulus
- Fairness

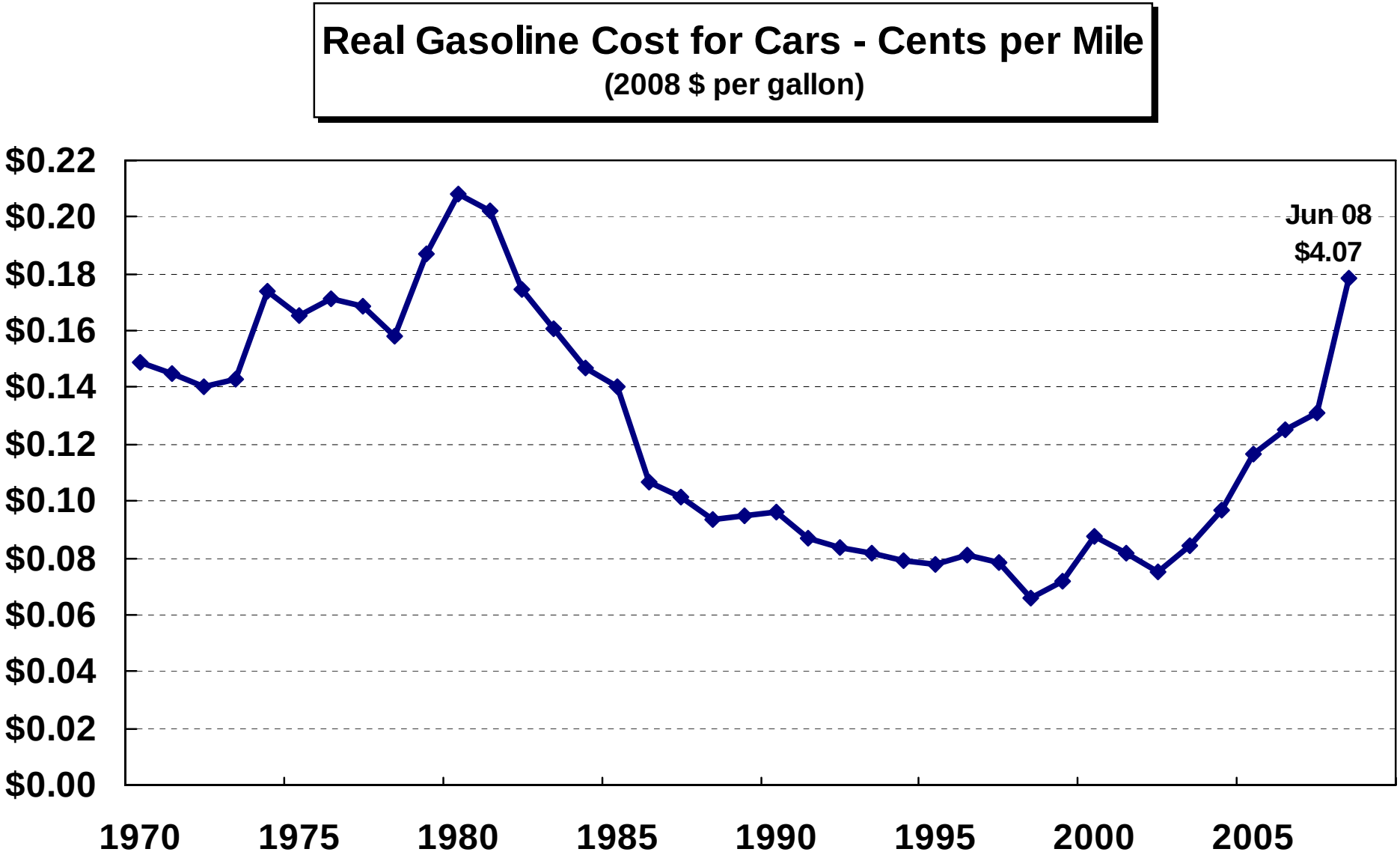
Industry

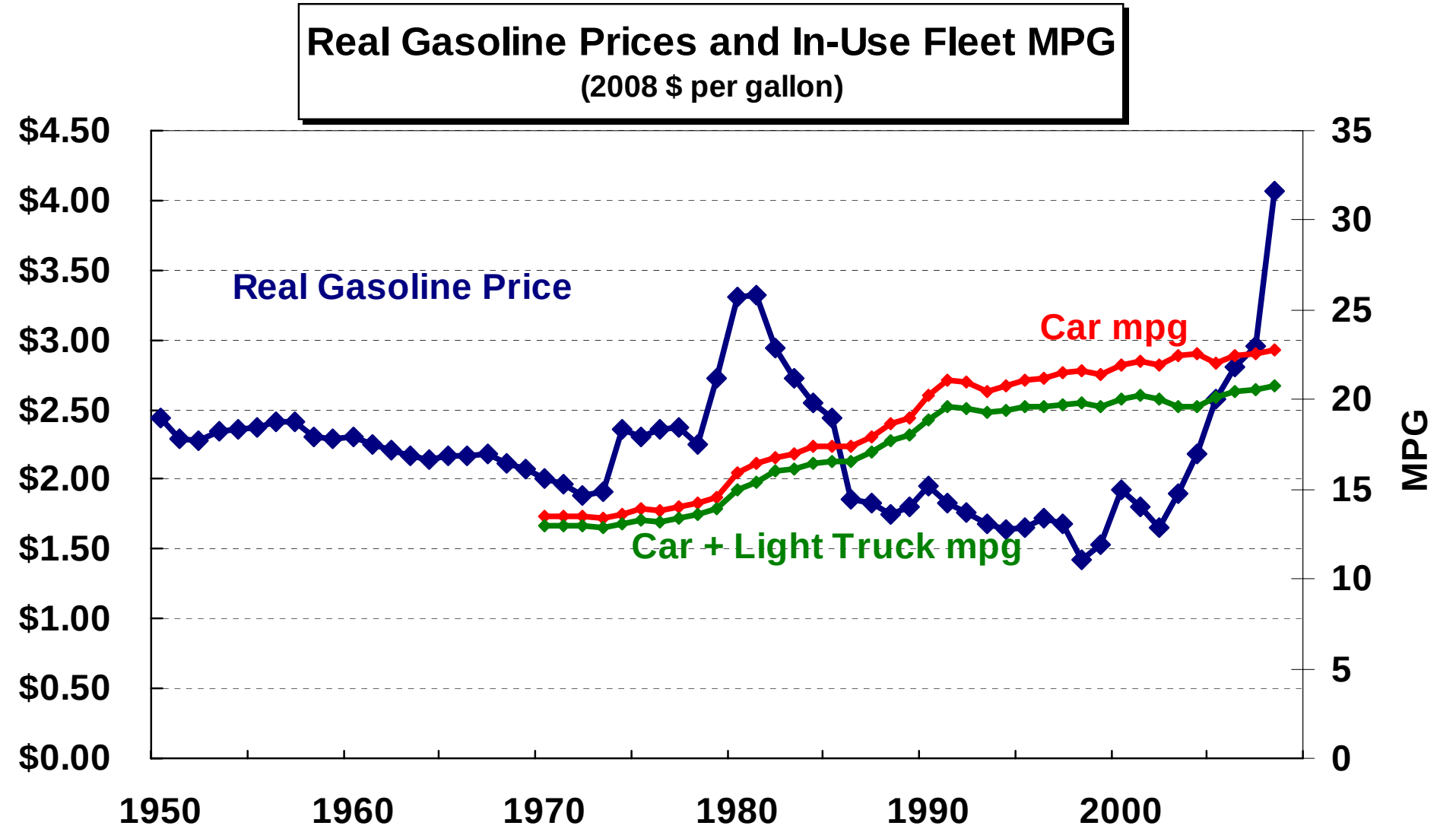
- Future Forecasting
- Risk Mitigation
- Quality
- Cost (Production, Materials)

Customer

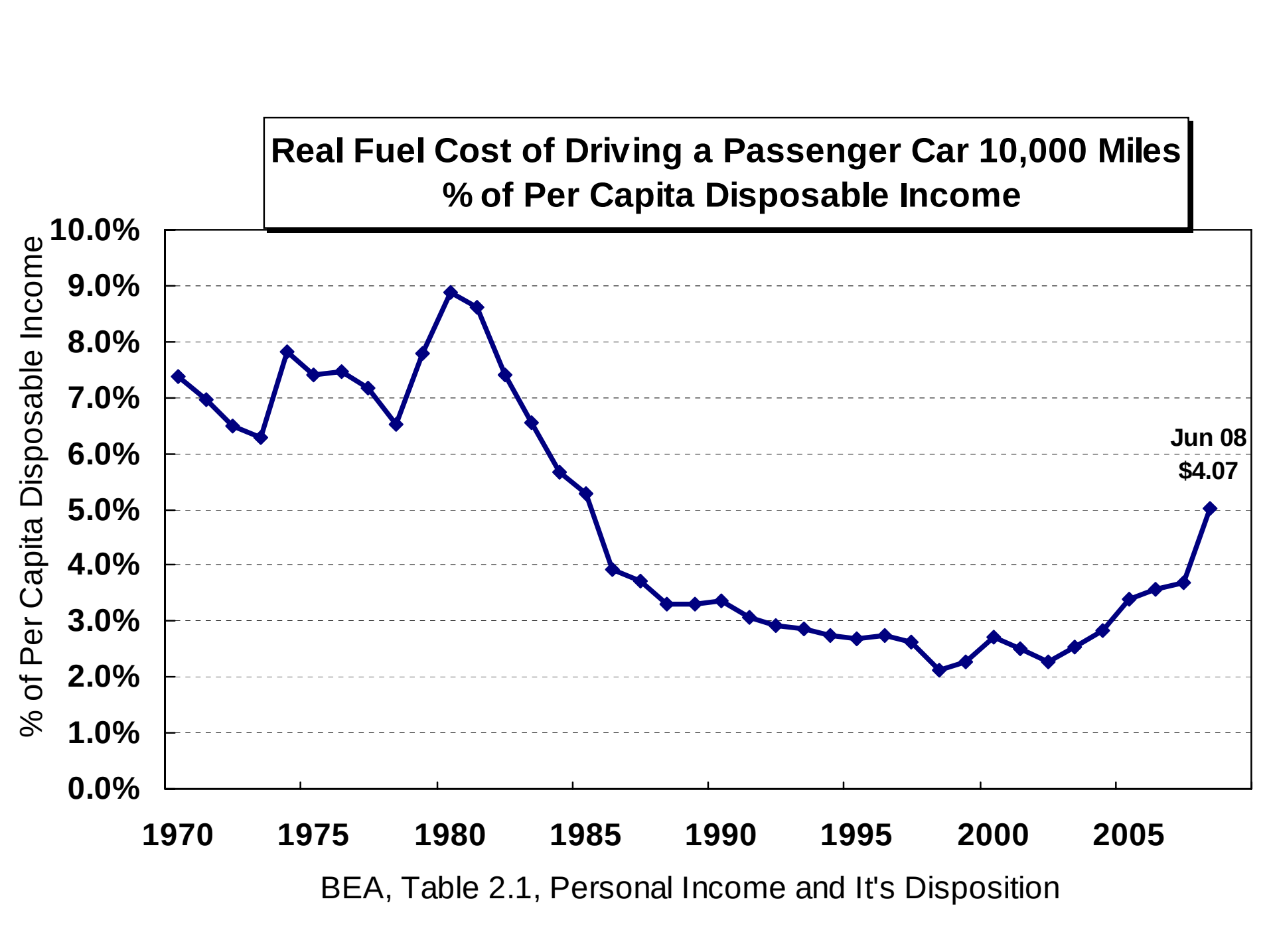
- Risk Mitigation
- Utility
- Affordability


Real Gasoline Prices
(2008 $ per gallon)
$4.50
$4.00
$3.50
$3.00
$2.50
$2.00
$1.50
$1.00
$0.50
$0.00
Jun 08
$4.07
1950
1960
1970
1980
1990
2000
Motor Gasoline Retail Prices, U.S. City Average, adjusted using CPI-U


Real Gasoline Cost for Cars - Cents per Mile
(2008 $ per gallon)
$0.22
$0.20
$0.18
$0.16
$0.14
$0.12
$0.10
$0.08
$0.06
$0.04
$0.02
$0.00
Jun 08
$4.07
1970
1975
1980
1985
1990
1995
2000
2005



In-Use MPG from Transportation Energy Data Book: 2007


Real Fuel Cost of Driving a Passenger Car 10,000 Miles
% of Per Capita Disposable Income
% of Per Capita Disposable Income
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
1970
1975
1980
1985
1990
1995
2000
2005
Jun 08
$4.07
BEA, Table 2.1, Personal Income and It's Disposition

Customer Uncertainty and Loss Aversion

David Greene – Asilomar, August 2007

- Uncertainty about several key elements of the net present value calculation makes an expenditure on higher fuel economy a ***risky bet***.
  - What MPG will ***I*** get (your mileage may vary on label)?
  - How long will my car last?
  - How much driving will I do?
  - What will gasoline cost?
  - What will I have to give up or pay to get better mileage?
- Application of universal consumer loss aversion functions and uncertainty explains the fundamental behavior that causes the market to produce less fuel economy than is economically efficient
  - And likely explains market preference for attributes that may not be valued higher but are simply more certain – performance, luxury, etc

New Technologies = Huge Risks

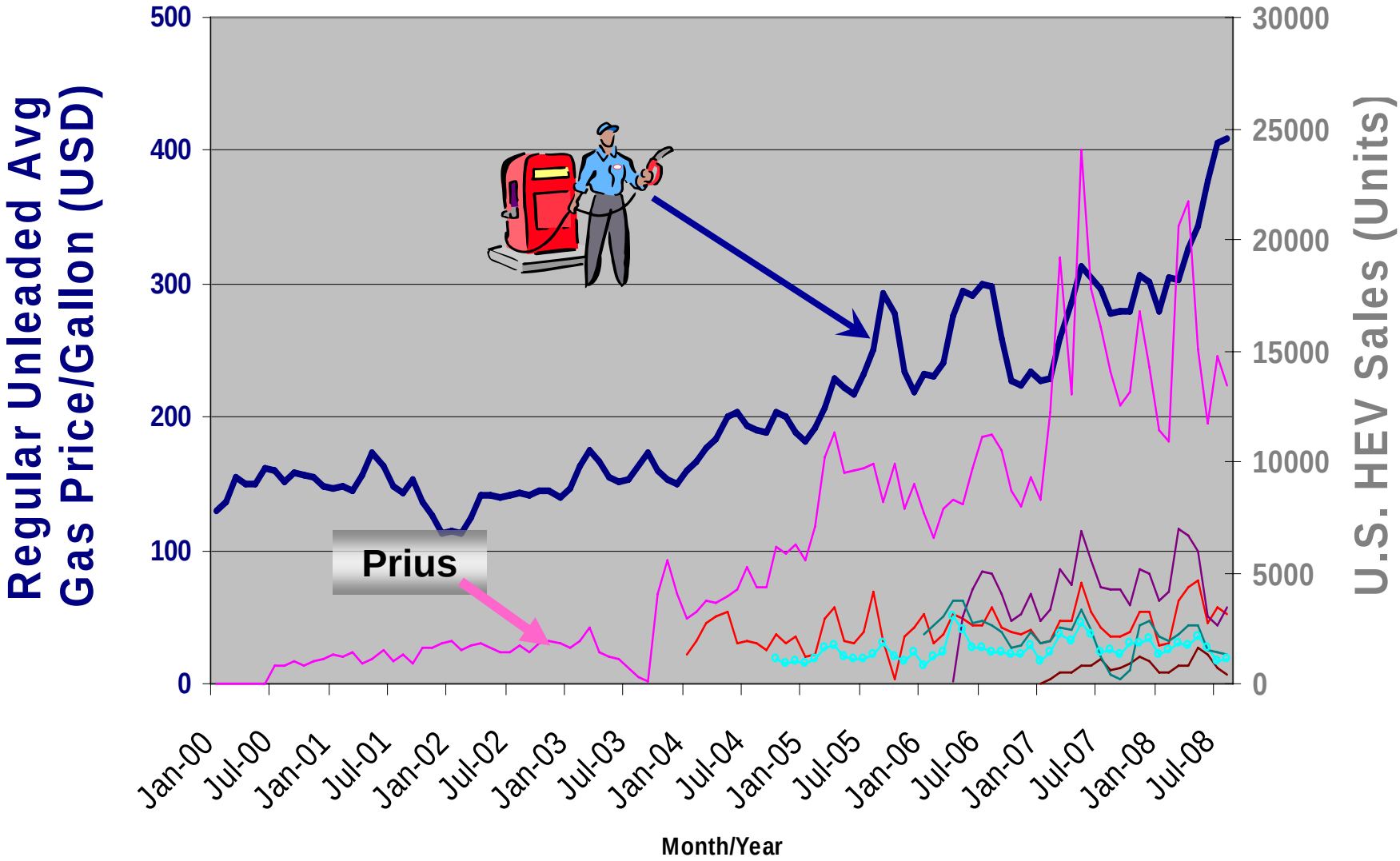
- Ironically, there are far too many technology options
  - Multitude of technology options, each with unknown future costs and technology synergies
- Market is very competitive – customers discount FE
- Manufacturer at a competitive disadvantage if the selected technology ultimately proves to be more expensive
- Even worse is widespread adoption of a technology that does not meet the customer expectations for performance and reliability.
  - Hurts manufacturer's reputation
  - Sets back acceptance of the technology for everyone (early 1980s diesel)

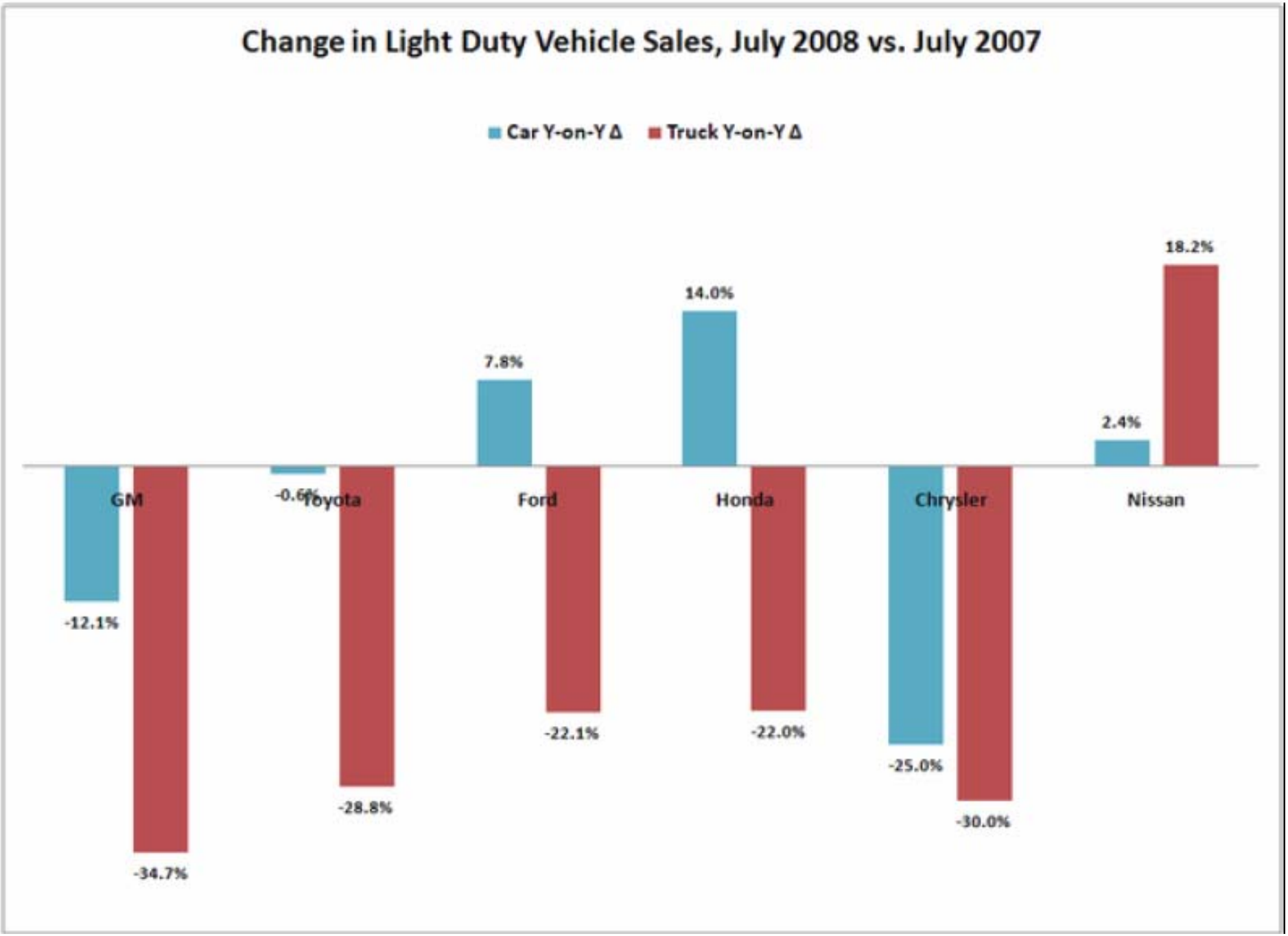
Fuel Price has Little Technology Impact

- Fuel price impacts vehicle size, performance, & VMT
- Fuel price does **not** have a major impact on technology penetration
  - **Size/performance** reductions **reduce** initial **purchase cost and** future **fuel costs**.
    - Cost benefits are clear to purchasers
  - Technology **increases** initial **purchase cost**. The increase in initial purchase cost offsets the fuel savings
    - **Net benefits are not clear** to purchasers, especially since **most** new vehicle purchasers severely discount future fuel savings

U.S. HEV Sales and Average Gas Prices

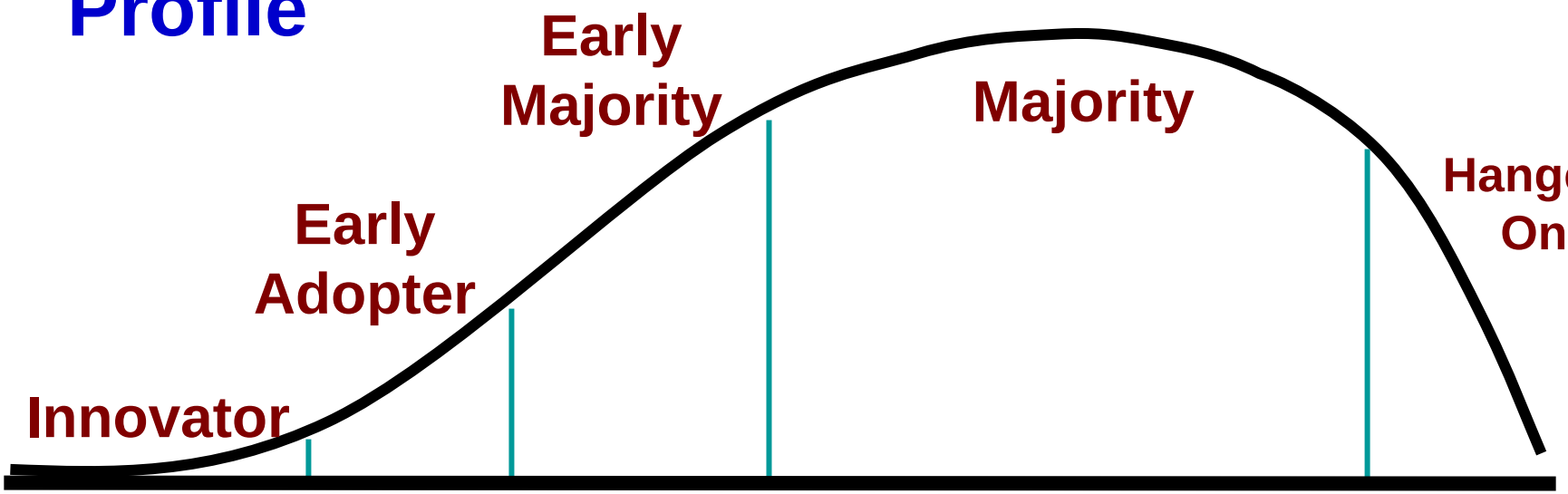
(Prius, Camry, Civic, RX400H, Escape, Vue, Altima)




Change in Light Duty Vehicle Sales, July 2008 vs. July 2007
Car Y-on-Y Δ
Truck Y-on-Y Δ
GM
-12.1%
-34.7%
Toyota
-0.6%
-28.8%
Ford
7.8%
-22.1%
Honda
14.0%
-22.0%
Chrysler
-25.0%
-30.0%
Nissan
2.4%
18.2%

Who is the buyer?

Customer Profile



Insight-Prius-Civic

Increasingly risk averse – applies to new technology, not just fuel economy

Need Higher Fuel Prices and Regulation

Direct and Indirect Influences on Transportation Sector GHG Emissions

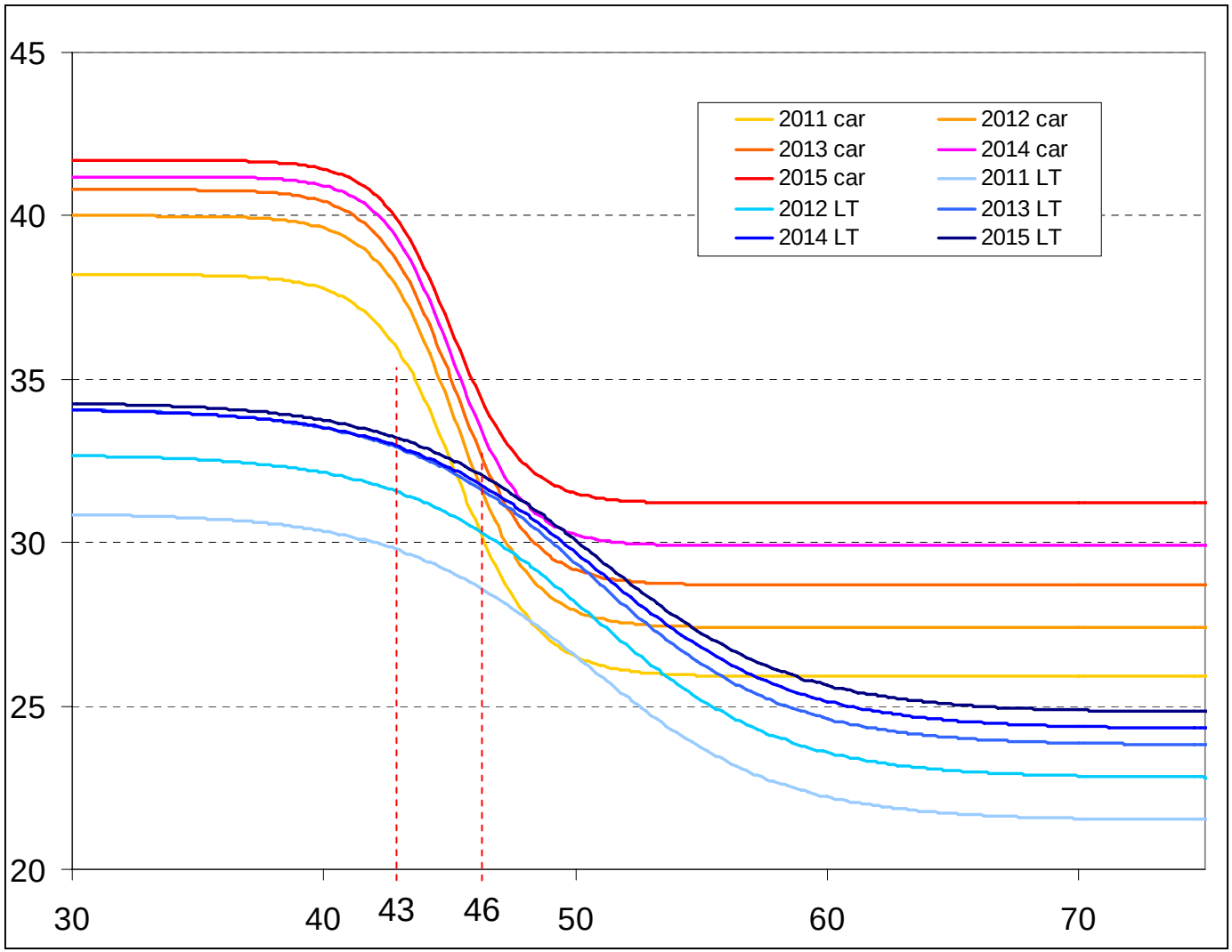
Factor/Entity		Vehicle Miles Traveled	Vehicle Efficiency			Carbon content
Strategy	Primarily affects		Leap-Forward Technology	Technology spread	Smaller vehicles	Alternative fuels
Fuel price (taxes)	**Consumers**	+			+	+ (if fuel price difference)
Land Use & Infrastructure	Consumers	+				
Technology mandates/ incentives	Manuf.		+			+ (w/ enough dollars)
CAFE or **Feebates**	**Manuf.**			++	(possible but small impact)	+

CAFE and Feebates fill the same gap between societal and consumer value of fuel savings

New CAFE law is a game changer

- Honda supported new CAFE law, but it is very challenging
  - 35 mpg by 2020 overall
    - Annual improvement over twice historical rate
    - All must go to fuel economy, not other attributes
  - **"Maximum feasible" standards through 2030**
- Don't know how NHTSA will allocate CAFE burden:
  - Among cars versus LDT
  - Slope of the attribute-adjustment curve for cars and LDTs

Attribute-Based Standards are Different NHTSA Attribute Curves for 2011-15



If high fuel prices shift market to smaller vehicles, the smaller footprint automatically raises standards – no change in stringency

Each Manufacturer has its own standard.

- Regulates efficiency (technology), not fuel economy

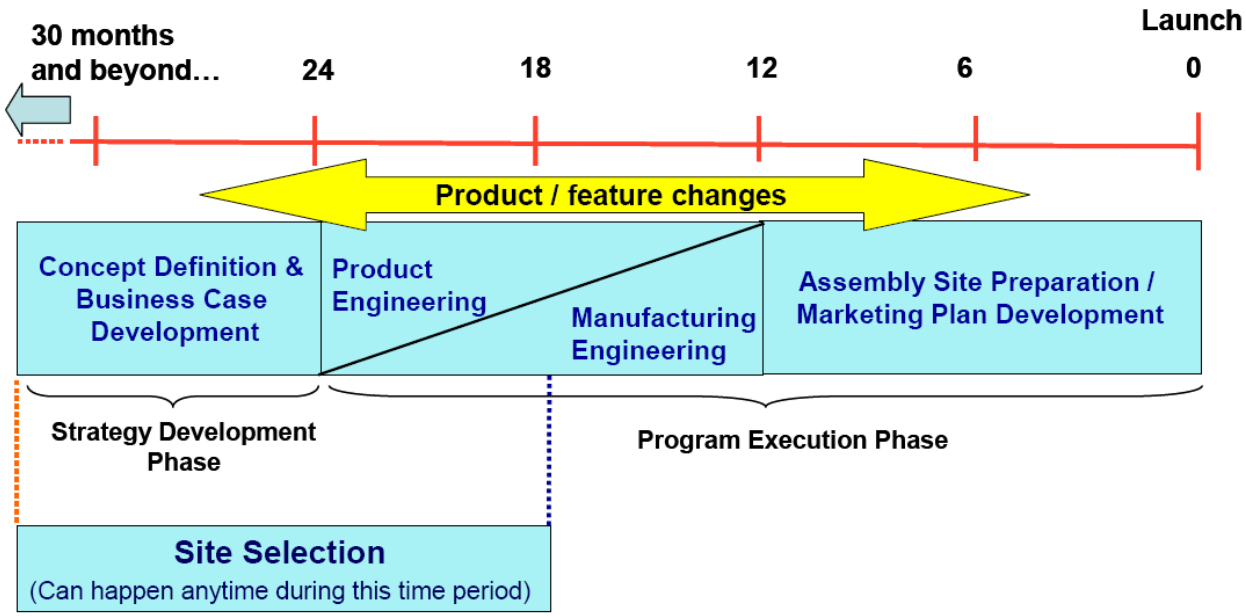
The Real Barrier - Leadtime

- Must allow time to ensure quality and reliability
  - Rigorous product development process – 2-3 years after feasibility has been demonstrated
  - Prove in production on a limited number of vehicles – 2-3 years
  - Assess impact of higher volume and further development on costs before committing to a single technology
  - Spread across fleet – 5-year minimum product cycles
- Longer leadtime is needed for new technologies
- Costs increase dramatically if normal development cycles are not followed
  - Greatly increases development costs, tooling costs, and the risk of mistakes

Primer on Automotive Business Planning

HOW AUTOMAKERS PLAN THEIR PRODUCTS, Center for Automotive Research, July 2007

Figure E-1. The Automotive Product Development Timeline



Source: Center for Automotive Research.

"Automobiles require long lead times for design, development and production planning (including tooling and supplier contracting). The process of developing a new program, whether for a new or redesigned vehicle or a powertrain, typically spans two and one-half years from concept to launch, as illustrated in Figure E-1."

"because vehicle programs carry over a high level of components and engineering from other programs, product changes are almost always evolutionary. Moreover, intrinsic time lags—the two- to three-year lead time for product development, the even longer planning cycle for all of a company's products, as well as the evolutionary nature of product change—represent constraints that must be respected.

Any potential policy requirements must acknowledge these realities. Indeed, it is difficult for automakers to do too much too fast. They are constrained by money, human resource issues and tooling costs, to name but a few."

The Ignored NAS Finding

2002 NAS Study - EFFECTIVENESS AND IMPACT OF CAFE STANDARDS

Finding 15. Technology changes require very long lead times to be introduced into the manufacturers' product lines. Any policy that is implemented too aggressively (that is, in too short a period of time) has the potential to adversely affect manufacturers, their suppliers, their employees, and consumers. Little can be done to improve the fuel economy of the new vehicle fleet for several years because production plans already are in place. The widespread penetration of even existing technologies will likely require 4 to 8 years. For emerging technologies that require additional research and development, this time lag can be considerably longer.

National Requirements are Essential

- Not the same as criteria pollutant control
  - Emission requirements were met with catalysts and improved air/fuel control, not complete vehicle redesign
- Vehicles are designed, manufactured, marketed, and distributed nationally
- Separate state requirements would divide resources and increase costs and leadtime concerns, with little benefit
- **Limited engineering resources**

Reality

- **Real cost of driving is still low**
- **Fuel prices have little impact on technology**
  - Customers greatly discount fuel savings, due to uncertainty
  - To minimize leadtime constraints, government should set ***long-term performance*** requirements and incentives
- **New CAFE standards regulate efficiency (technology), not overall mpg**
- **CAFE law requires "maximum feasible", not 35 mpg in 2020**
- **Finite engineering resources the primary constraint on increasing efficiency**
  - State requirements divert resources and slow innovation
  - Need clear, long term, and consistent national policy signals

Thank you!

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