CAR
CENTER FOR AUTOMOTIVE RESEARCH

U.S. Auto Industry in Recovery and in 2025

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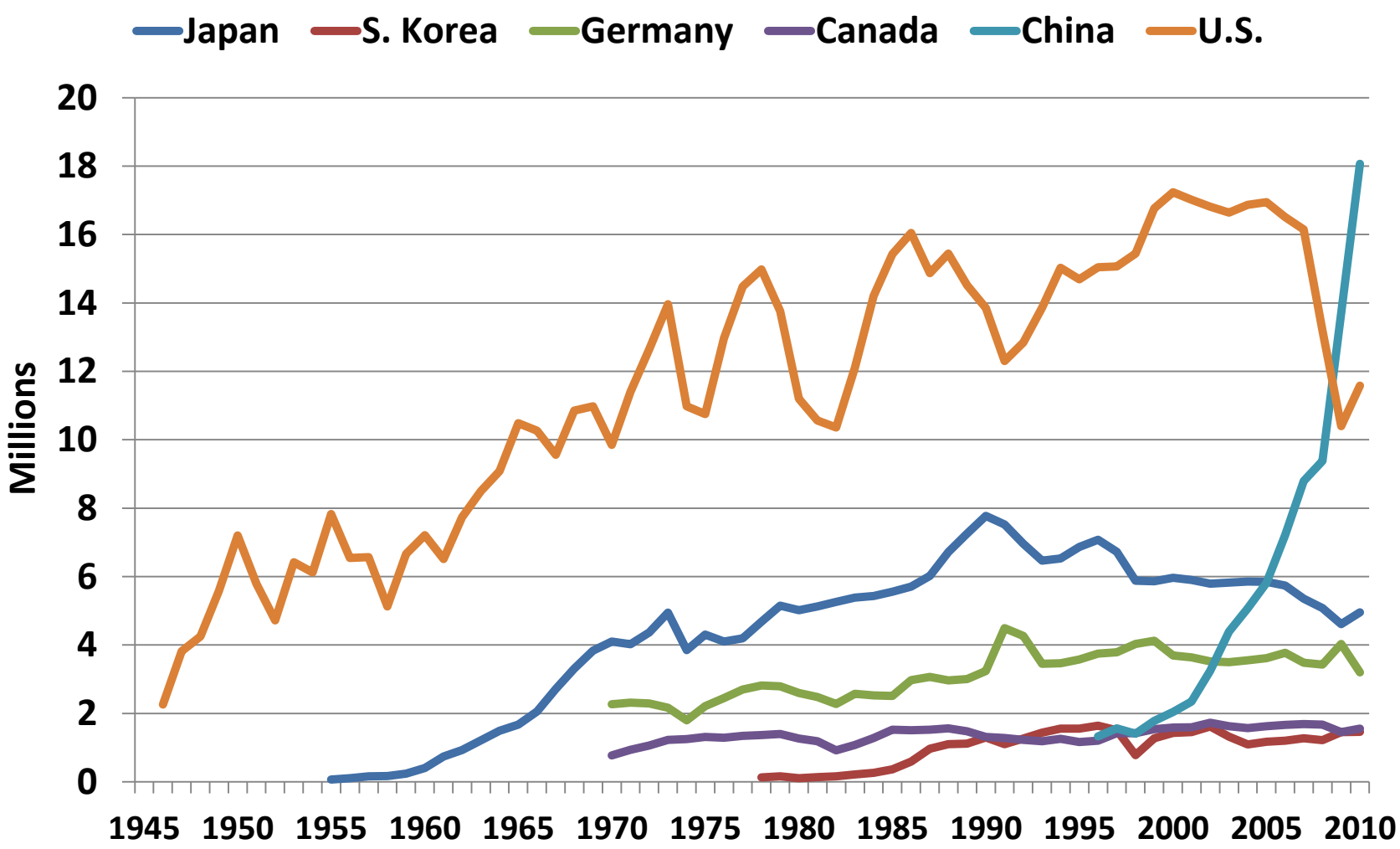
May 18, 2011
Great Designs in Steel Seminar
Steel Market Development Institute
Livonia, Michigan

So What Is Next?

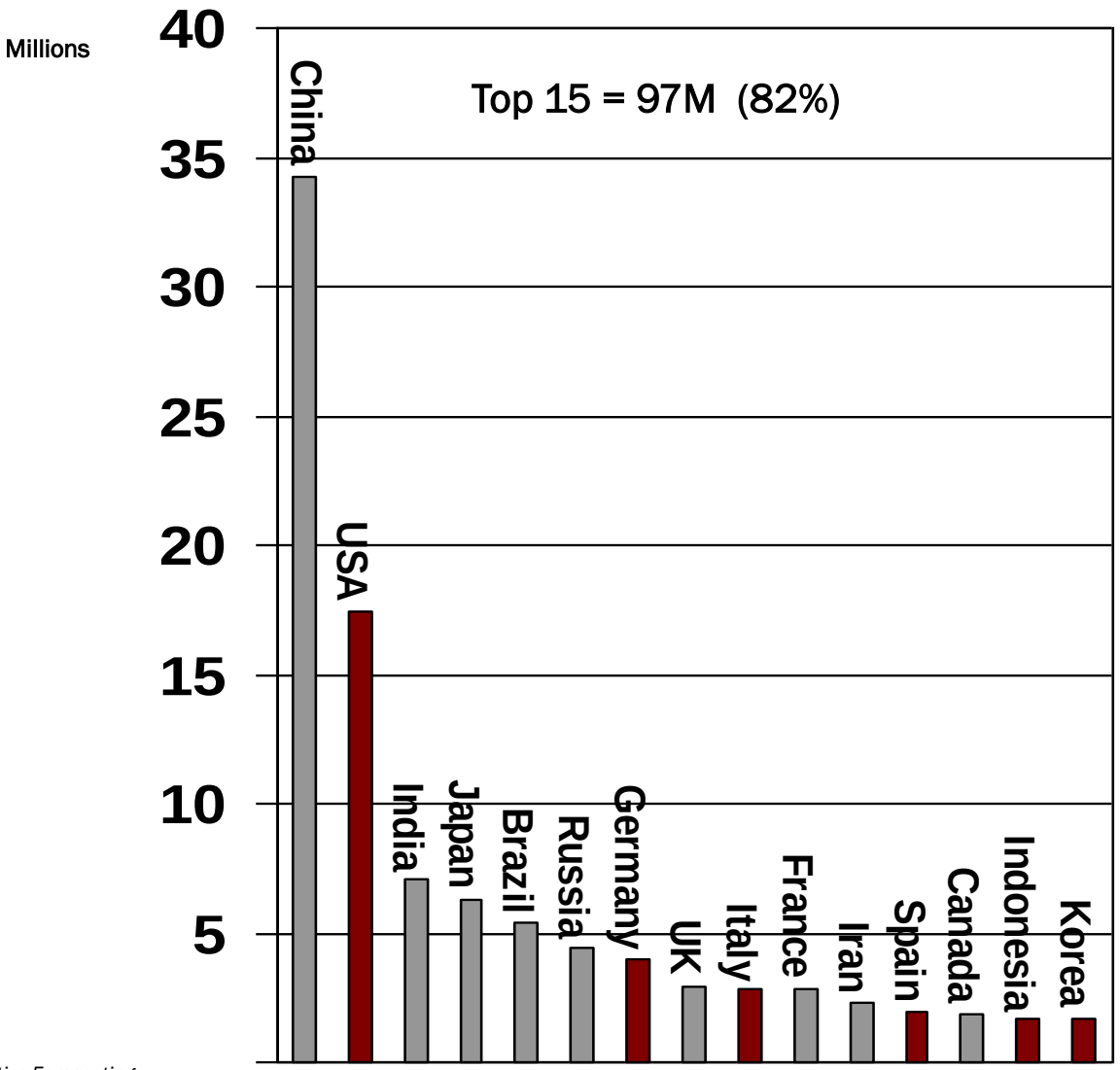
$14,235,969,697,878.39

bp

Motor Vehicle Sales By Countries:



Top 15 Global LV Markets 2020



Source: J.D. Power Automotive Forecasting

U.S. Sales and Production
(Will Vehicles Get Smaller?)

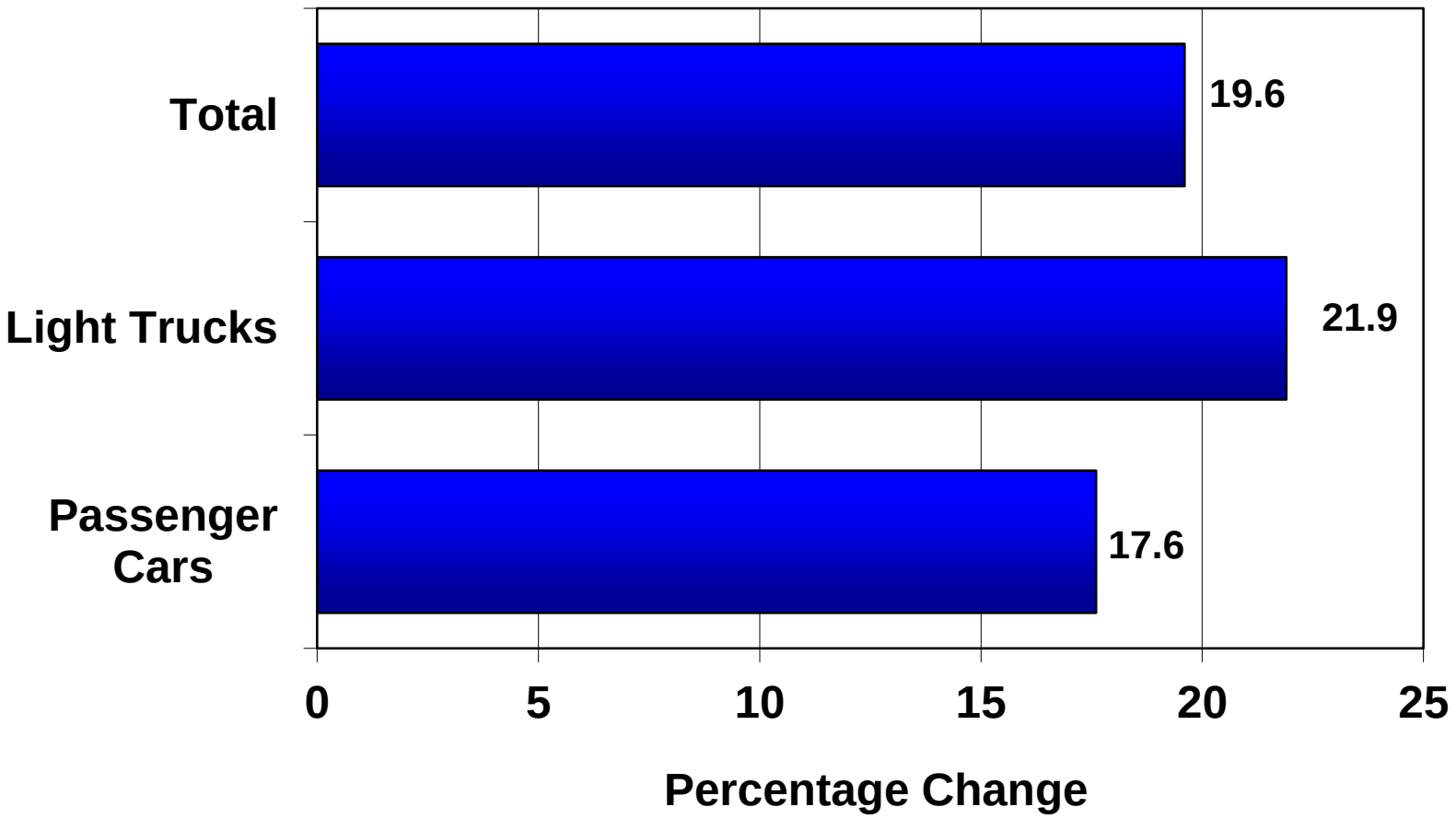
U.S. Auto Sales & Production Will Steadily Improve with Economy

- GDP Growth is Moderate (Slow)
- Used Vehicle prices and age of fleet are high
- Credit is more available/stock market recovering
- Dollar is low against Yen and OK against Euro
- Bin Laden is gone Bye Bye

But . . .

- Unemployment rate and length is terrible
- House prices are still falling and will fall more . . .
- States/Cities cutting spending and employment
- Consumer confidence was improving, now falling . . .
- Gas prices spiking with food prices
- Higher commodity prices = higher auto prices
- Japan crisis might halt automaker production as parts run short

U.S. Light Vehicle Sales Percent Change
YTD Through April: 2011 vs. 2010

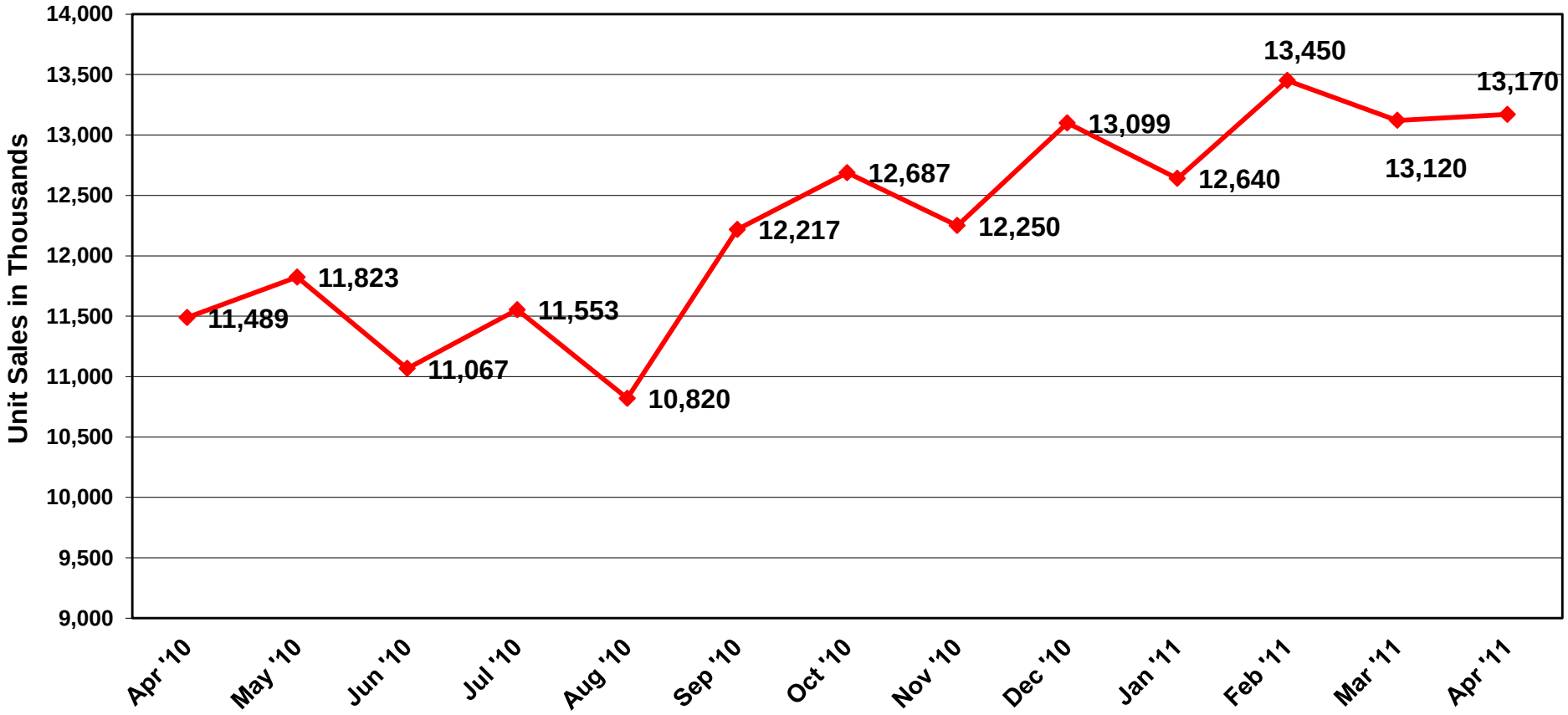


Source: Automotive News

Steady But Slow Improvement

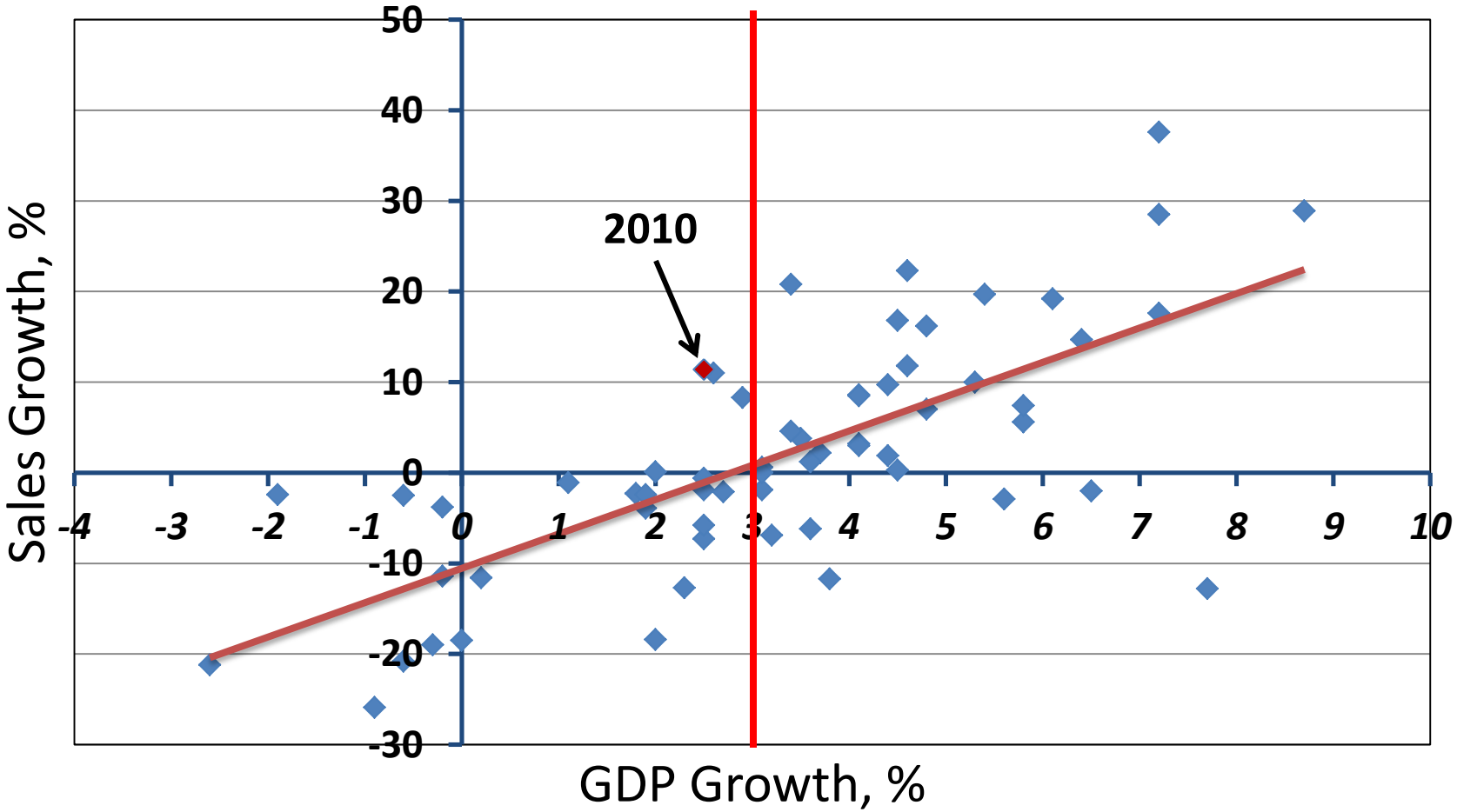
U.S. Light Vehicle Sales Monthly SAAR:

April 2010 Through April 2011



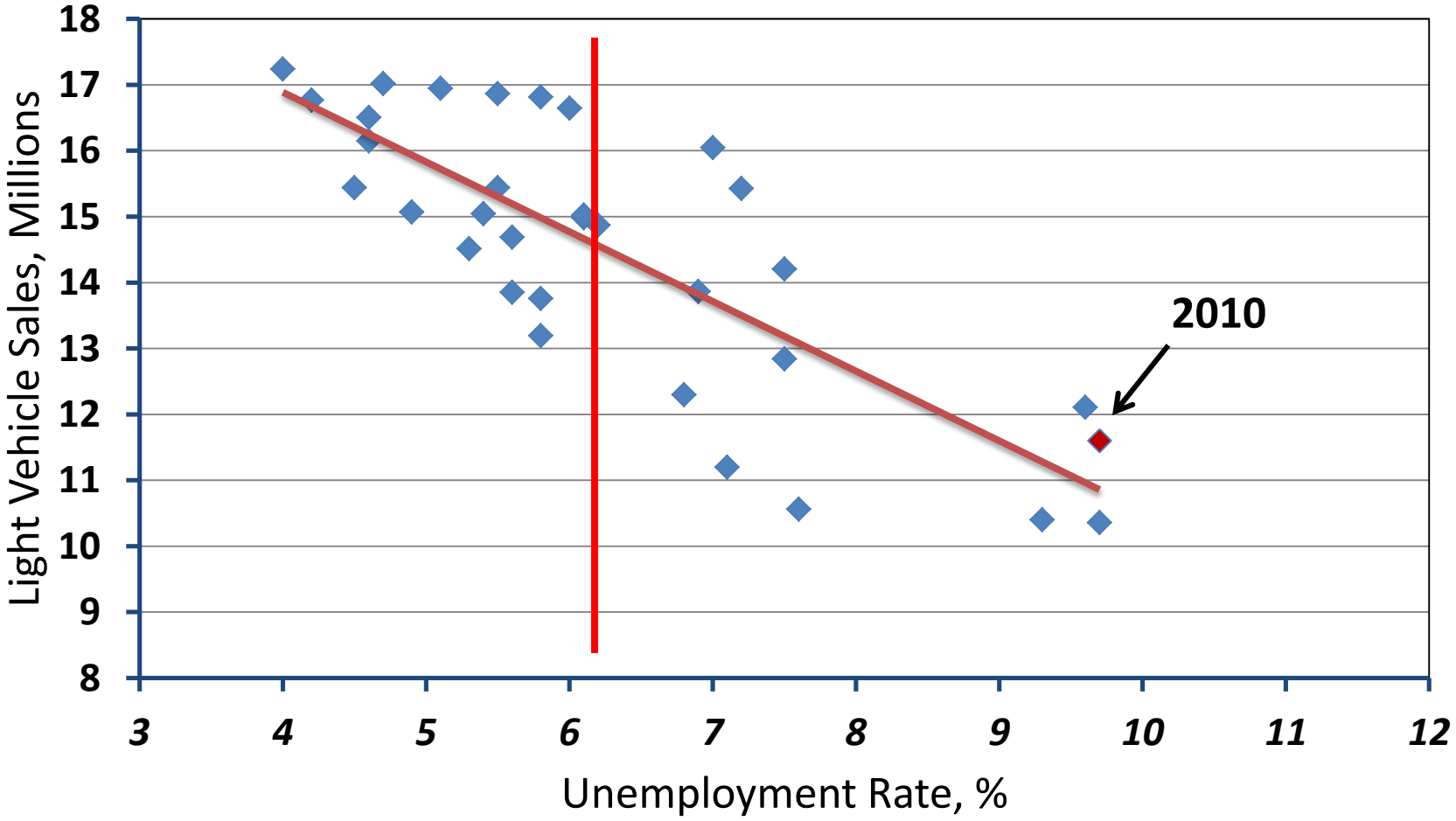
Source: Automotive News Data Center

Only 1.8% Growth in 1st Quarter
Need 3% GDP Growth To Have a Positive Sales Growth
GDP Growth Rate and Sales Growth Rate, 1950-2010

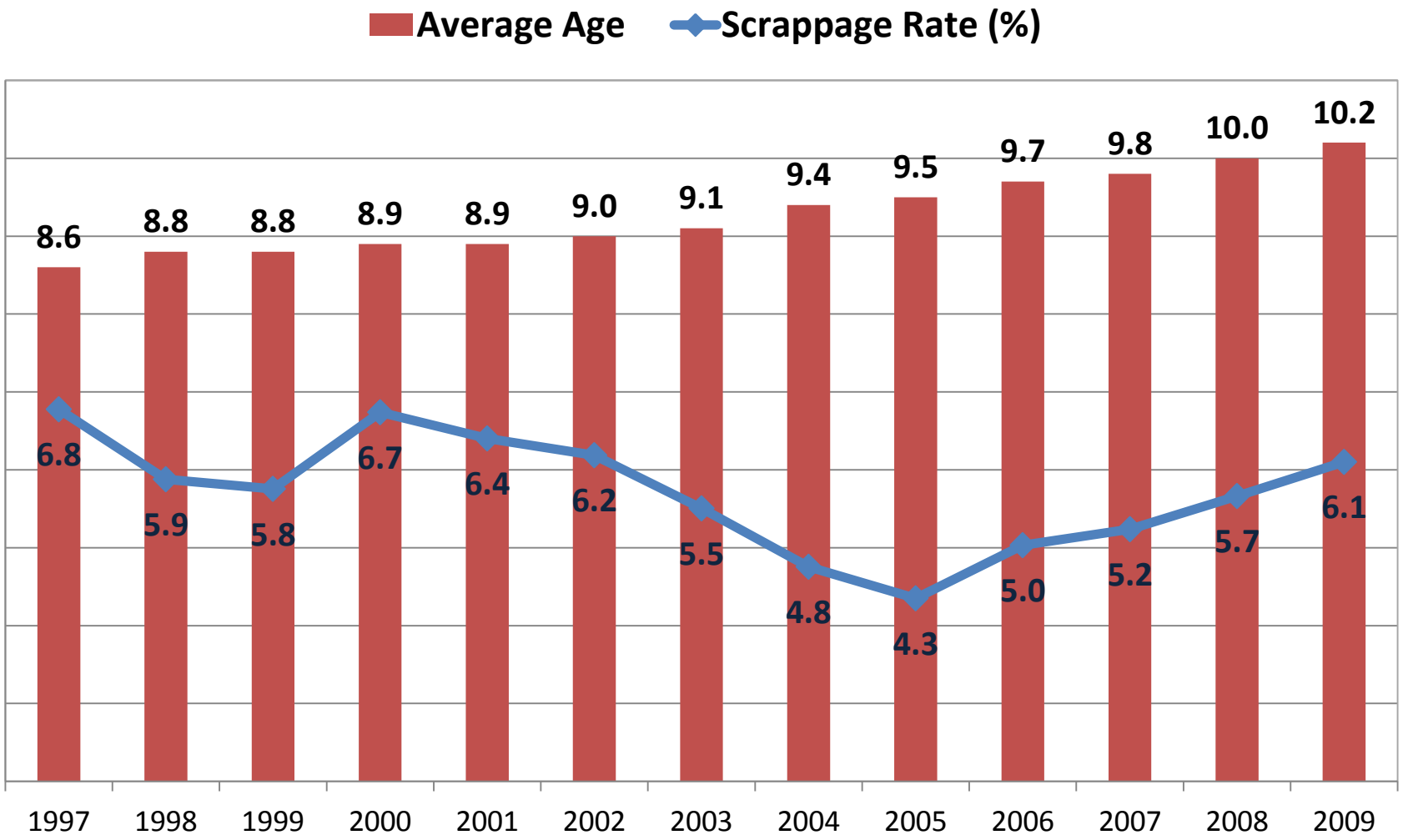


Back to 9%
Need Unemployment Rate Below 6%
to Have Growth?

Light Vehicle Sales and Unemployment Rate, 1978-2010

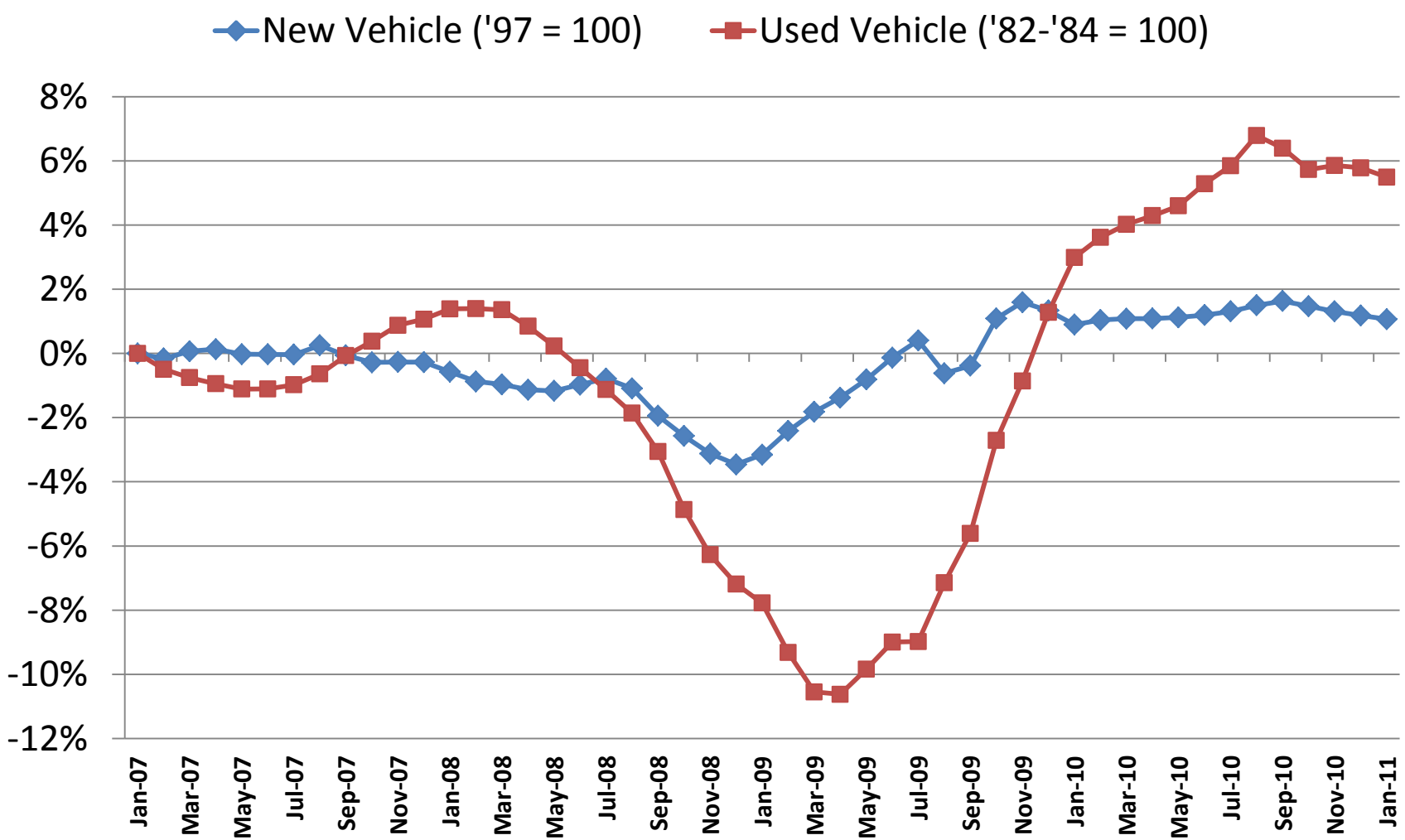


U.S. Light Vehicle Age and Scrappage Rate



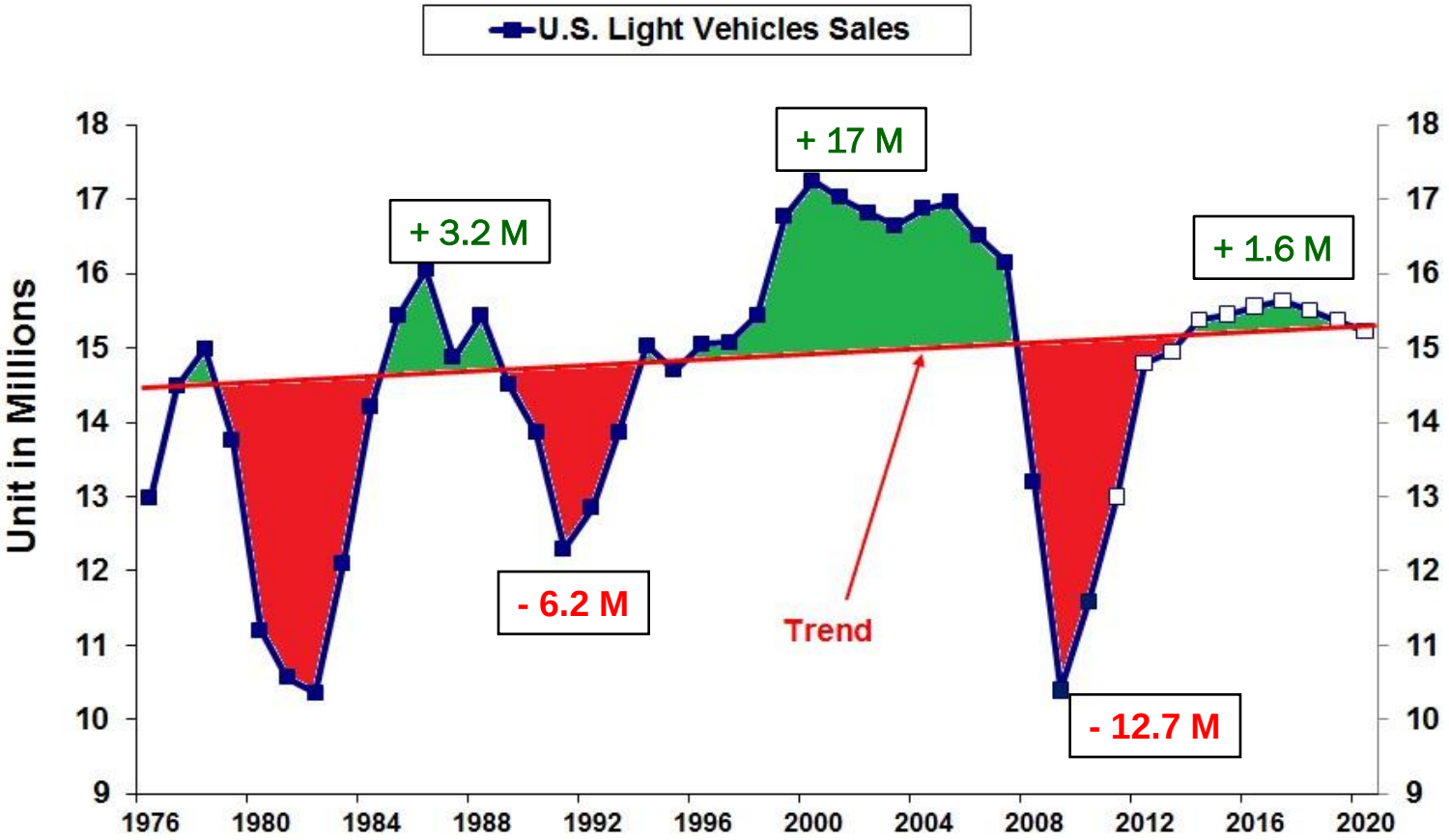
Source: R.L. Polk

Changes from Jan '07:
CPI-New Vehicle and CPI-Used Vehicle



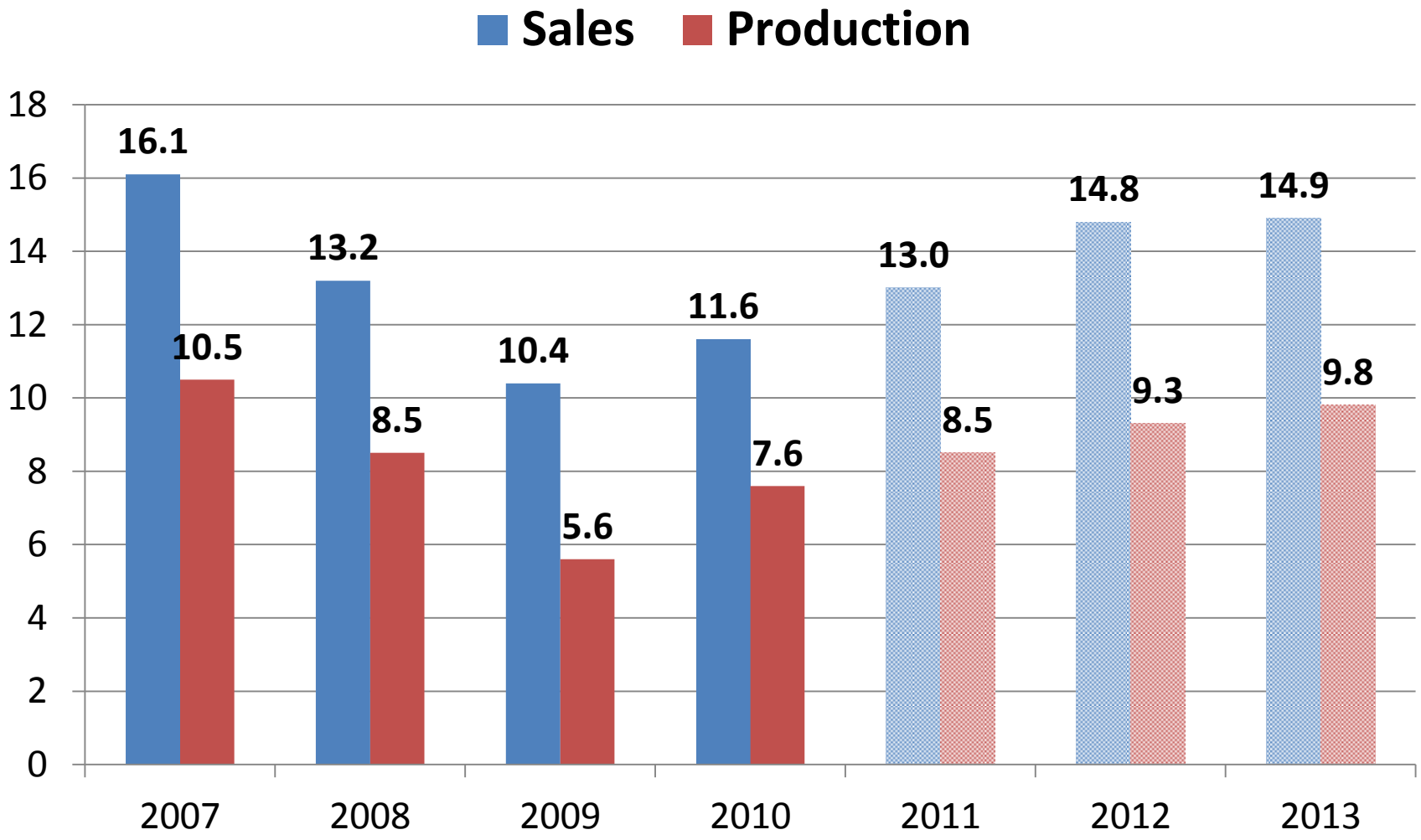
Source: BLS

CAR Sales Forecast



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
U.S. Sales (Millions)	13.0	14.8	14.9	15.4	15.5	15.6	15.6	15.5	15.4	15.2

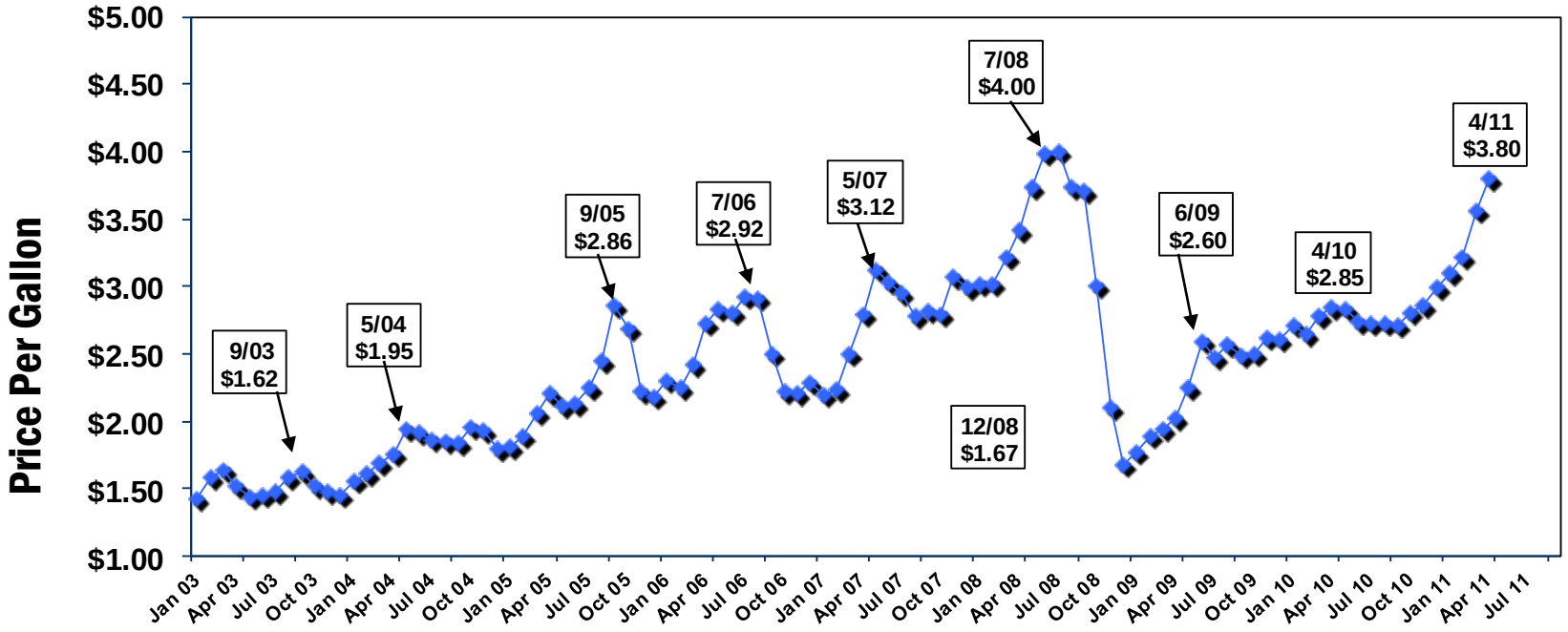
U.S. Light Vehicle CAR's Sales and Production Forecast



Source: CAR Research, IHS Global Insight

Another Spike

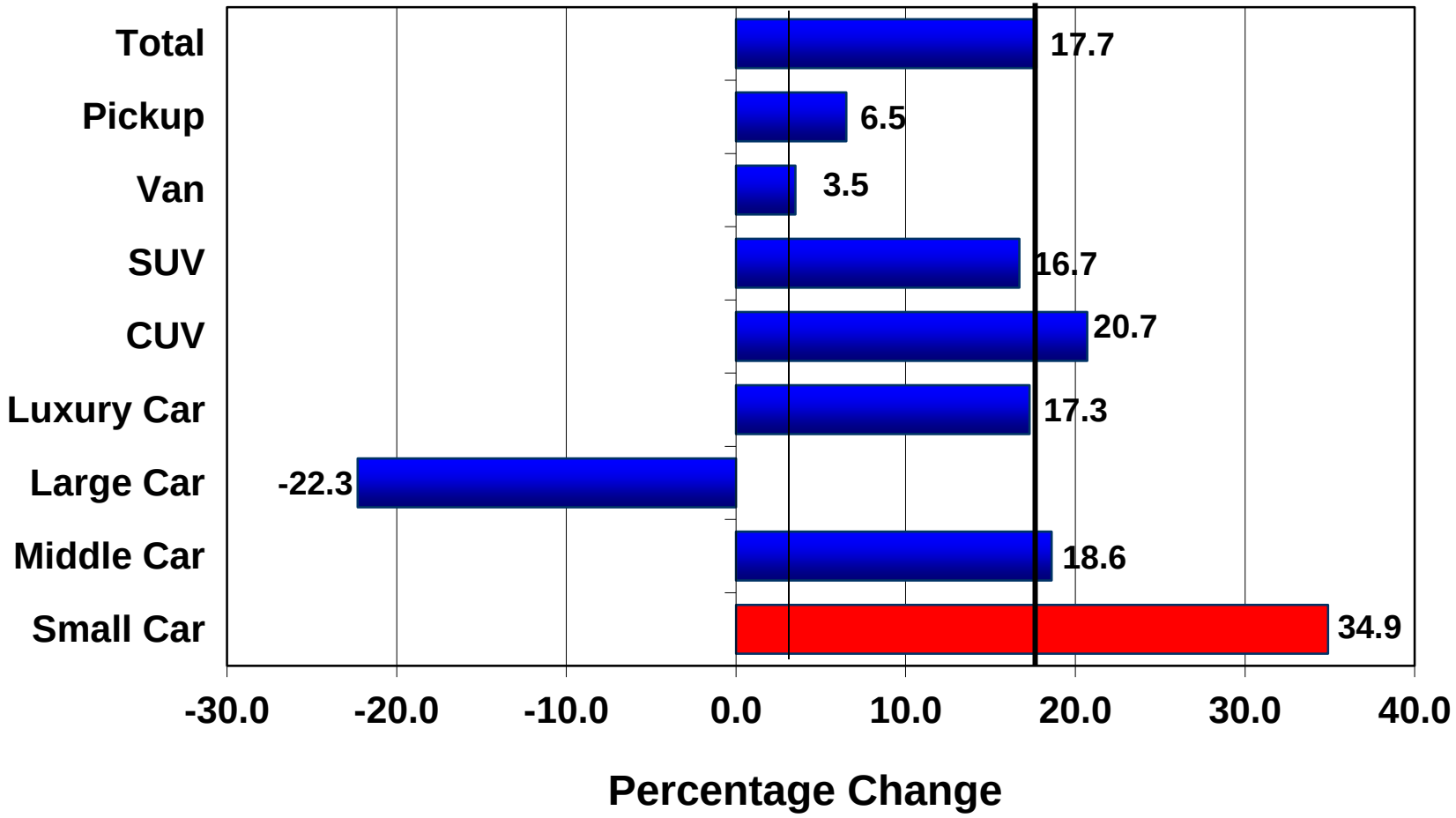
Gasoline Prices (Nominal)



Source: Energy Information Administration, USDOE, 6/8/09

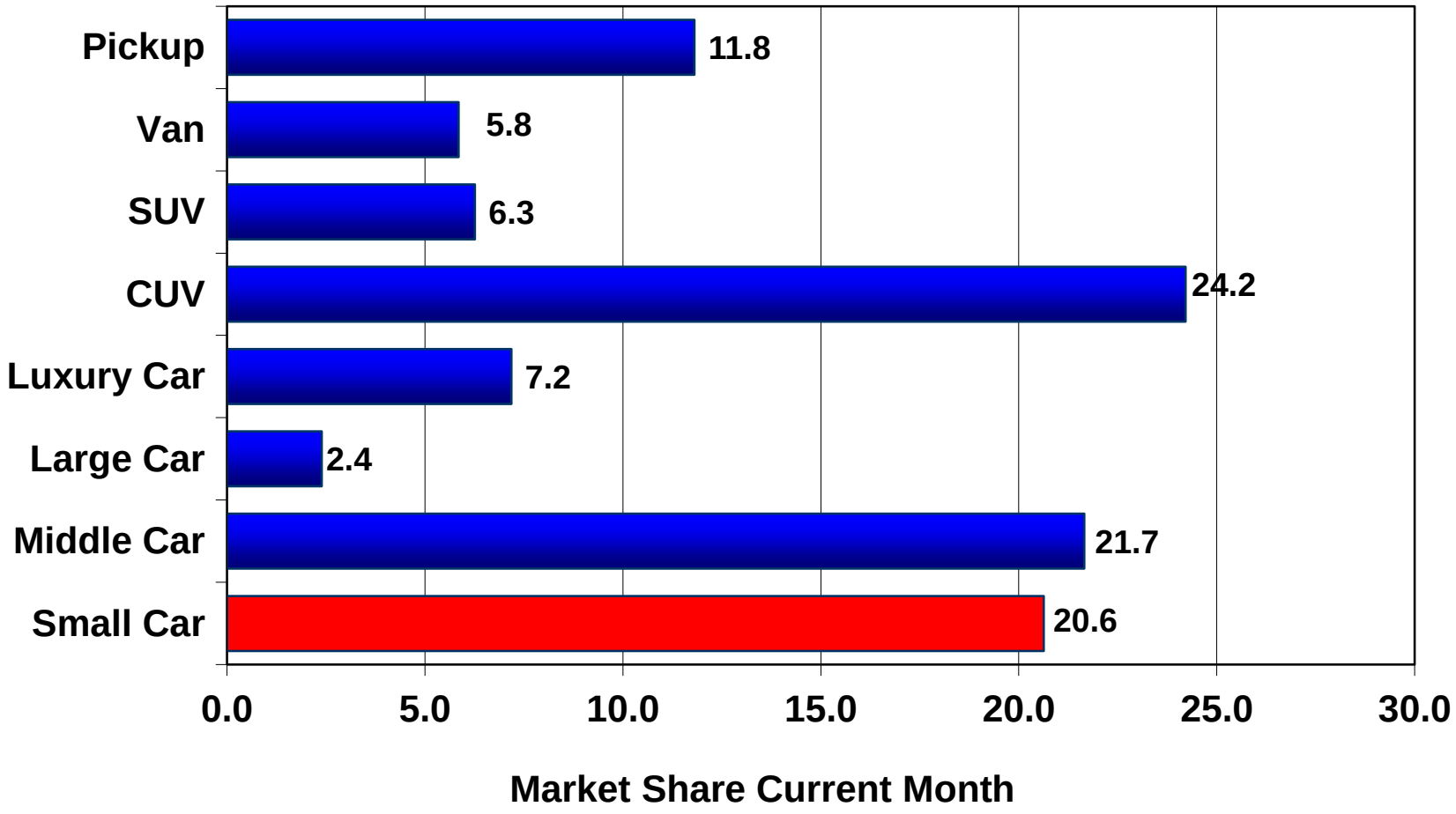
**Regular Conventional Gasoline*
All Price Nominal

Segment Breakdown - U.S. LV Sales Percent Change
April 2011 vs. April 2010



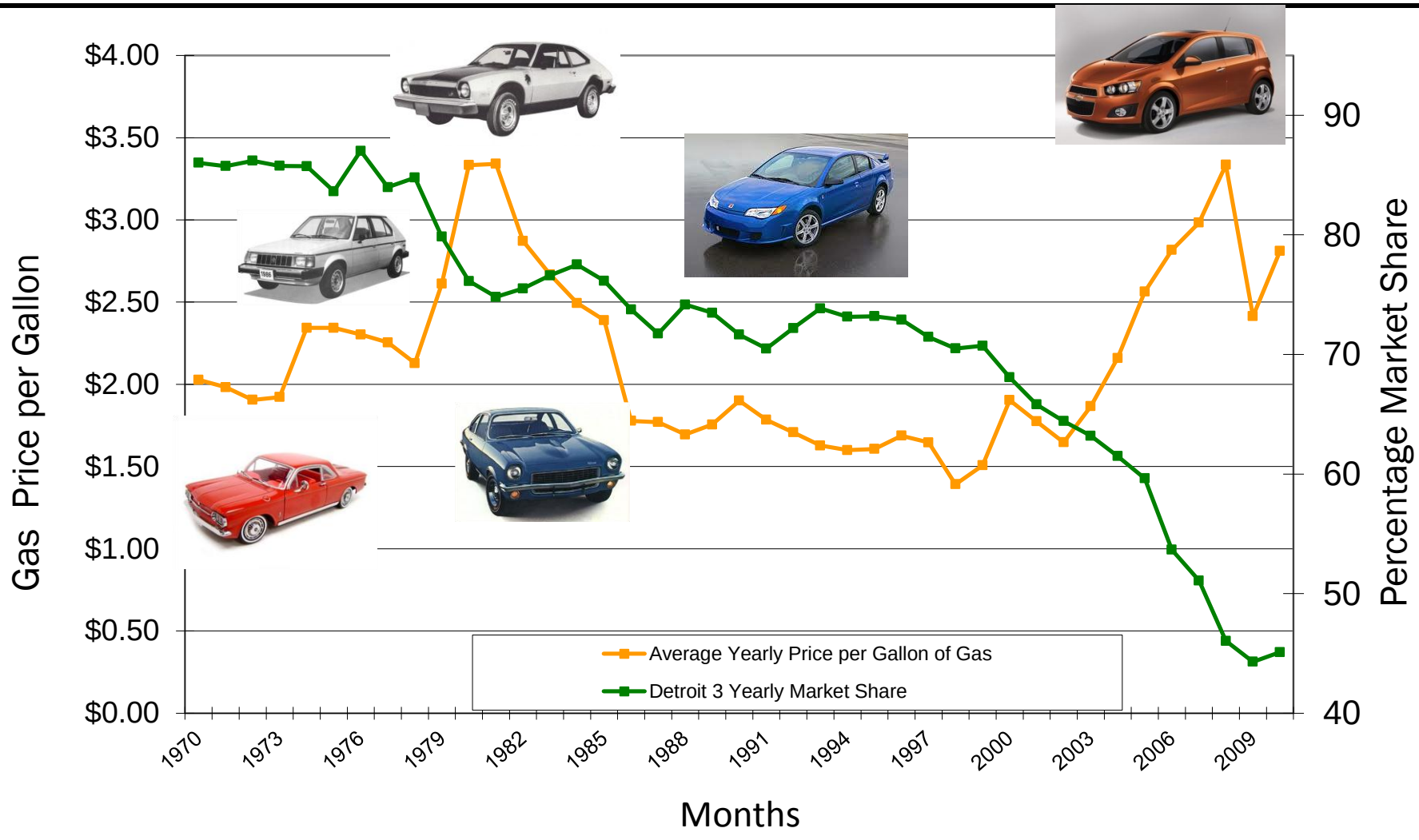
Source: Ward's Automotive Reports

April U.S. Light Vehicle Sales: Market Share by Segment



Source: Ward's Automotive Reports

Average Real Gasoline Price* and Detroit 3 U.S. Market Share 1970-2010



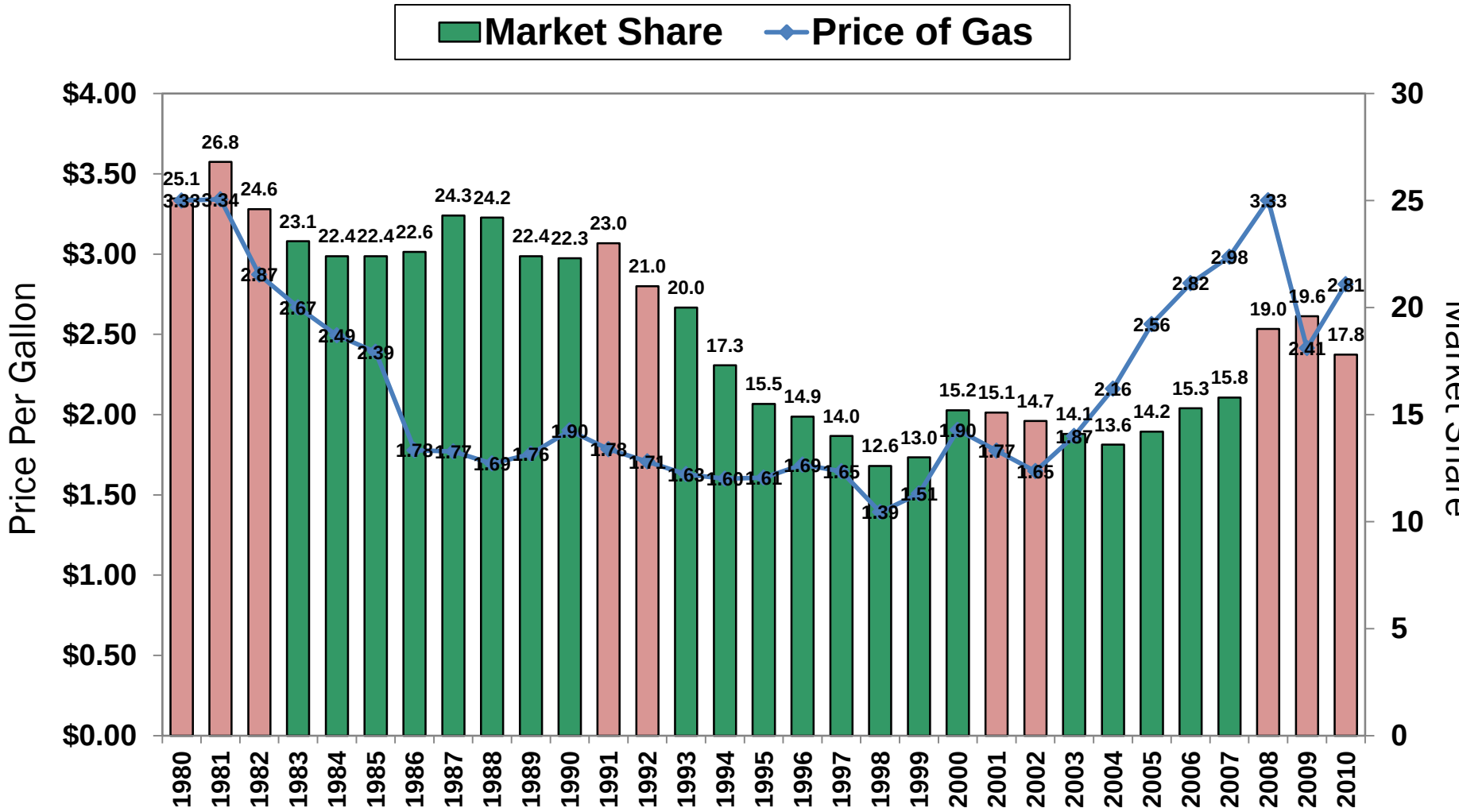
*Gas prices expressed in 2011 USD

Real Gasoline Price and D3 Market Share

Dependent Variable: D3MKT				
Method: Least Squares				
Sample (adjusted): 1986 2009				
Included observations: 24 after adjustments				
	Coefficient	Std. Error	t-Statistic	Prob.
C	96.46619	3.272152	29.48096	0.0000
GAS	-17.58972	1.843779	-9.540034	0.0000
R-squared	0.805331	Mean dependent var		66.29250
Adjusted R-squared	0.796482	S.D. dependent var		9.107380
S.E. of regression	4.108607	Akaike info criterion		5.743700
Sum squared resid	371.3743	Schwarz criterion		5.841872
Log likelihood	-66.92441	Hannan-Quinn criter.		5.769745
F-statistic	91.01225	Durbin-Watson stat		1.140955
Prob(F-statistic)	0.000000			

- For every 10 cent increase in real gasoline price, Detroit 3 market share drops by 1.7 percentage point.

Small Car Segment Market Share & Real Regular Gasoline Price: 1980-2010



Source: Ward's Automotive, Energy Information Administration

Small Cars Market Share Results

Dependent Variable: MKT				
Method: Least Squares				
Sample (adjusted): 1980 2009				
Included observations: 30 after adjustments				
Convergence achieved after 15 iterations				
MA Backcast: 1978 1979				
	Coefficient	Std. Error	t-Statistic	Prob.
C	34.44039	4.007248	8.594524	0.0000
INCOME	-0.000768	0.000142	-5.422039	0.0000
GAS	2.800797	0.804730	3.480420	0.0019
GDPR	-0.242260	0.101095	-2.396354	0.0247
MA(1)	1.226285	0.029495	41.57645	0.0000
MA(2)	0.918106	0.023180	39.60775	0.0000
R-squared	0.945034	Mean dependent var		18.93667
Adjusted R-squared	0.933583	S.D. dependent var		4.407320
S.E. of regression	1.135833	Akaike info criterion		3.269466
Sum squared resid	30.96280	Schwarz criterion		3.549706
Log likelihood	-43.04199	Hannan-Quinn criter.		3.359117
F-statistic	82.52692	Durbin-Watson stat		1.329571
Prob(F-statistic)	0.000000			
Inverted MA Roots	-.61+.74i	-.61-.74i		

Results:

One dollar increase in gasoline price per gallon will increase small car market share by 2.8%. However, a one thousand dollars increase in per capita personal disposable income will offset the small cars market share by 0.77%. Therefore, if gasoline price increases by one dollar, it takes $3,646 increase on per capita personal disposable income to cancel out the effect on small cars market share.

Materials and Fuel Economy

Material Trends

1. The current trend substituting for mild steel still has a way to go (e.g., aluminum doors and magnesium/ titanium/ composite components).

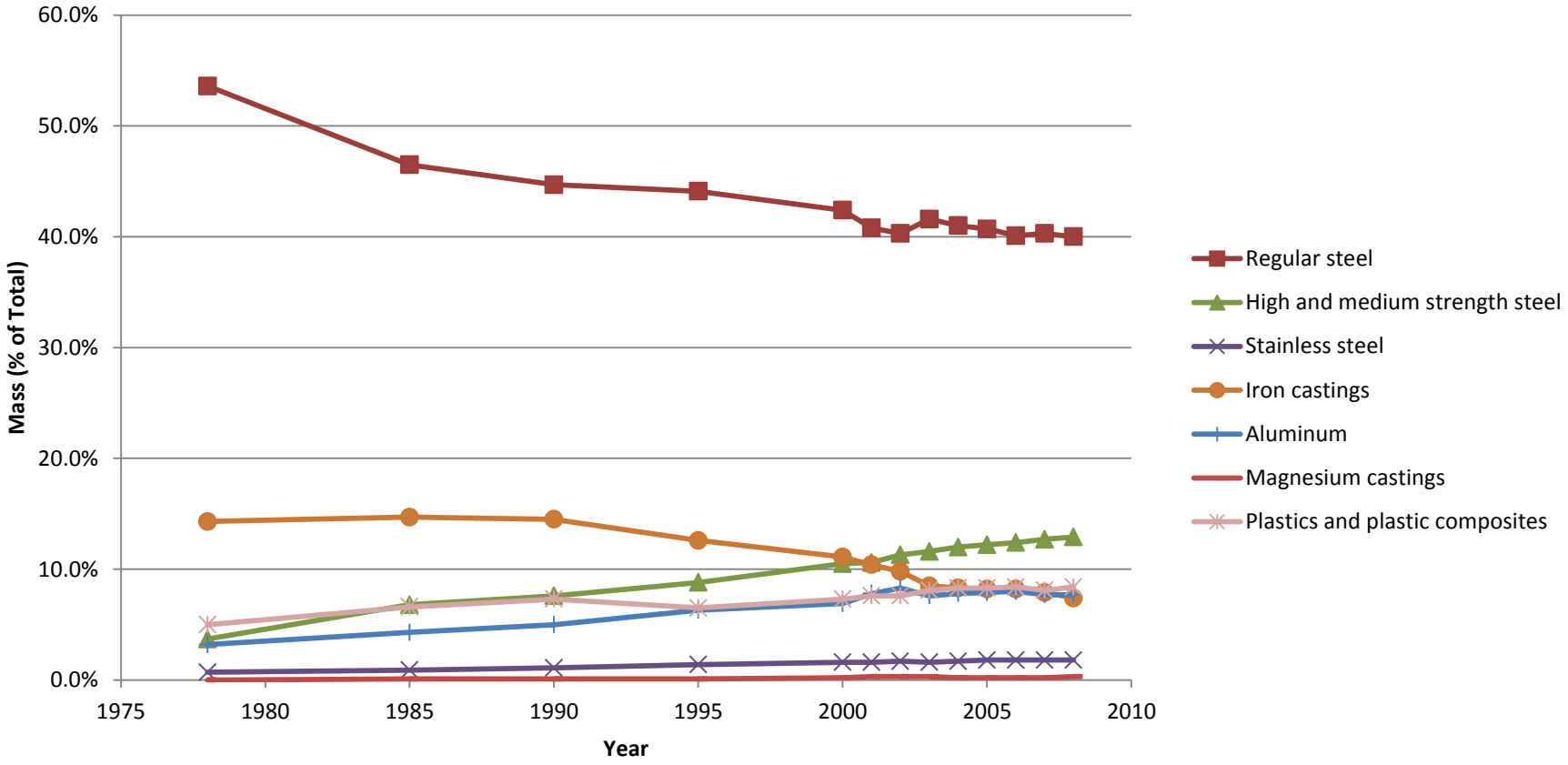
2. There is a threshold at which you can no longer continue to substitute lighter-mass materials due to structural performance (e.g., stiffness). (Other concerns arise with manufacturability, safety, repairability, recyclability and supply chain.)

3. Aggressive mass reduction will eventually require a significant architectural redesign to accommodate, for example:

   - Aluminum (e.g., space frame structure)
   - Magnesium & composites (major molded unibody components)

Average Material Consumption for a Domestic Light Vehicle

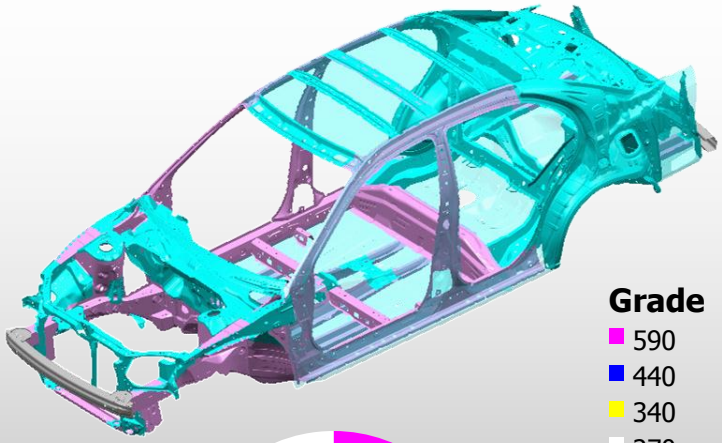
The average light vehicle in 2008 contained more than 2,000 pounds of steel, most of it conventional steel. High and medium strength steel, however, made up more than 10% of the vehicle. The use of aluminum grew from 1995 to 2008, while the use of iron castings declined.

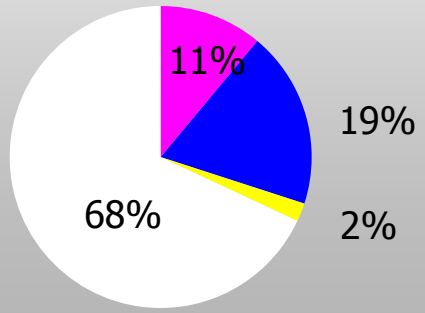


Ward's Communications, Ward's Motor Vehicle Facts and Figures, 2009, (and updates, 2010), Detroit, MI, 2009, p. 63

Today's Example of State-of-the-Art
Honda Civic

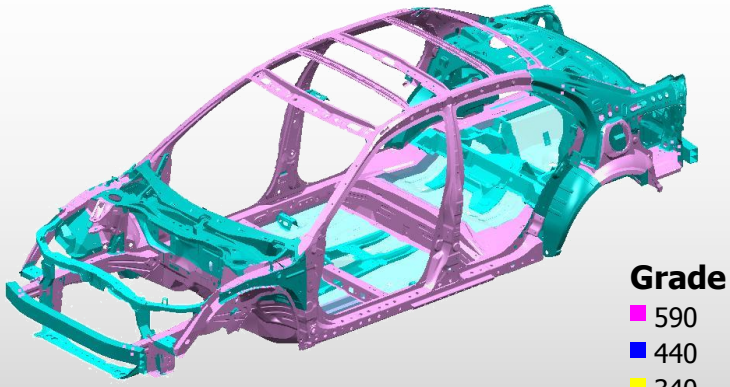
05M Civic

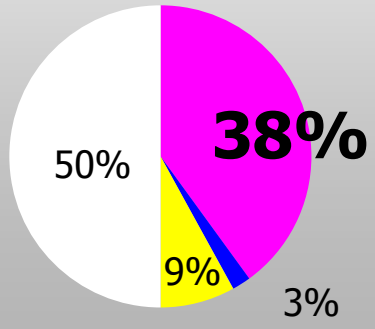




HSS Usage Rate: 32%

CIVIC





590 MPa steel use tripled

HSS Usage Rate: 50%

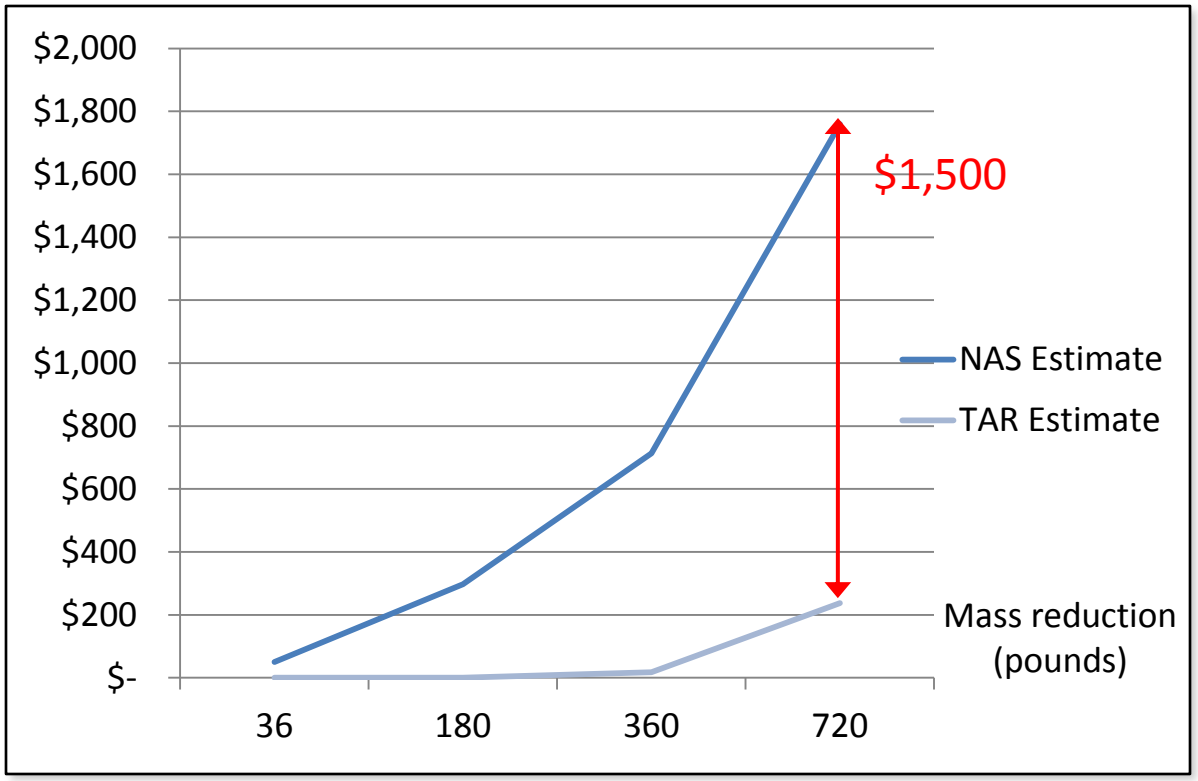
50% of body now high strength steel

Mass Reduction, in General, is not Free

More expensive materials, slower fabrication, joining/interface complexity

10% reduction in mass ➔ 6% - 7% reduction in fuel consumption

"Re-optimize" vehicle: 30% additional benefit in secondary mass reductions



EPA/NHTSA 2025 Technology Assessments

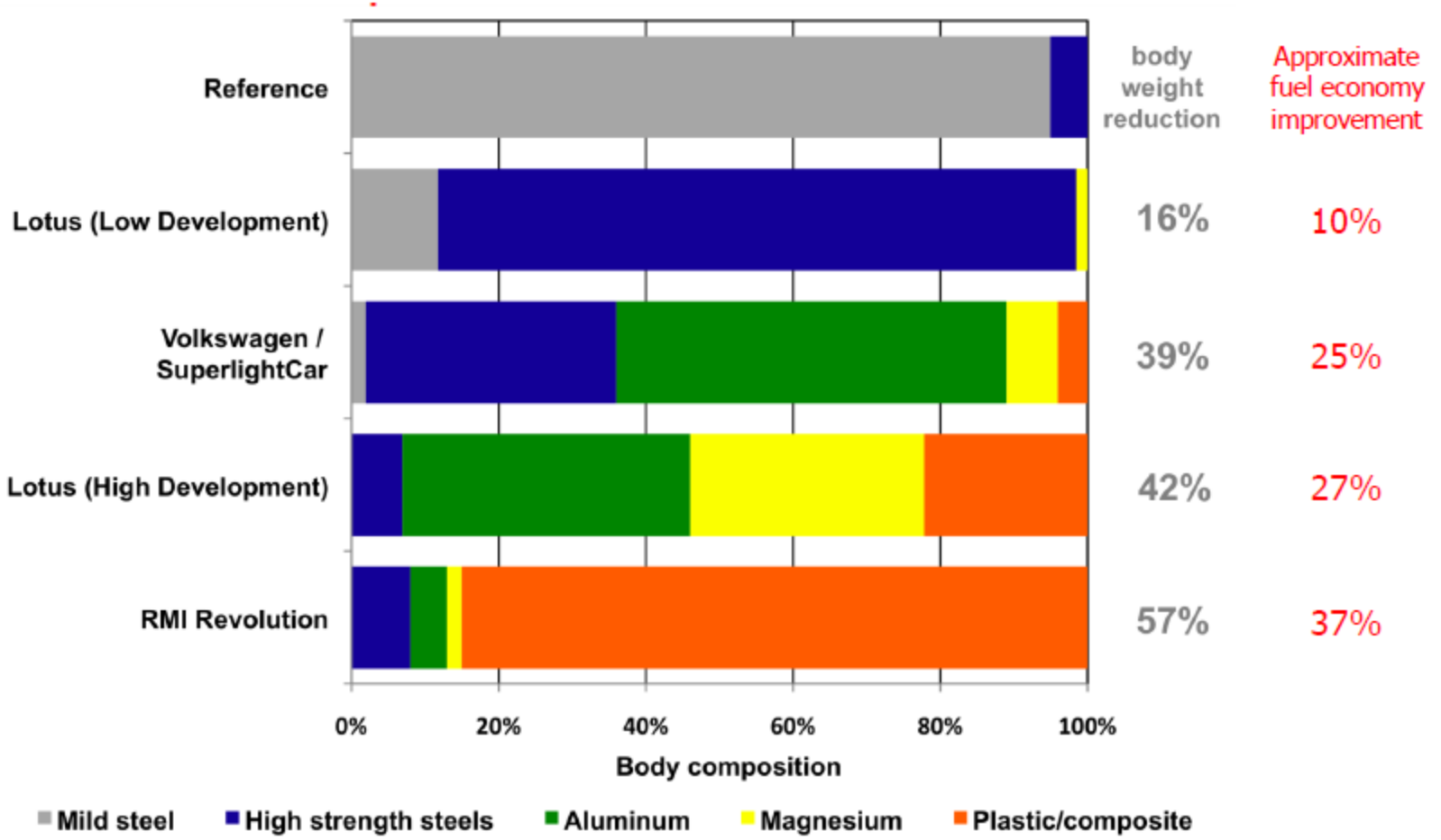
Scenario: 2025 Levels	Technology Path Focus	Mass Reduction	HEV Penetration	PHEV Penetration	EV Penetration	Preliminary Per-Vehicle Cost Estimates ($)	Monetary estimate of lifetime fuel saving ($)	Payback Period (years)
3%/year	HEV	15%	11%	0%	0%	$930	$5,930	1.6
	All	18%	3%	0%	0%	$850	$5,950	1.5
47 mpg 190 gCO_2/mi	ICE & lightweight	18%	3%	0%	0%	$770	$5,970	1.4
	PHEV/EV/HEV	15%	25%	0%	0%	$1,050	$5,950	1.9
4%/year	HEV	15%	34%	0%	0%	$1,700	$7,600	2.5
	All	20%	18%	0%	0%	$1,500	$7,500	2.2
51 mpg 173 gCO_2/mi	ICE & lightweight	25%	3%	0%	0%	$1,400	$7,600	1.9
	PHEV/EV/HEV	15%	41%	0%	4%	$1,900	$7,200	2.9
5%/year	HEV	15%	65%	0%	1%	$2,500	$9,000	3.1
	All	20%	43%	0%	1%	$2,300	$9,000	2.8
56 mpg 158 gCO_2/mi	ICE & lightweight	25%	25%	0%	0%	$2,100	$9,100	2.5
	PHEV/EV/HEV	15%	49%	0%	10%	$2,600	$8,100	3.6
6%/year	HEV	14%	68%	2%	7%	$3,500	$9,700	4.1
	All	19%	43%	2%	7%	$3,200	$9,800	3.7
62 mpg 143 gCO_2/mi	ICE & lightweight	26%	44%	0%	4%	$2,800	$10,200	3.1
	PHEV/EV/HEV	14%	55%	2%	14%	$3,400	$9,100	4.2

EPA/NHTSA Joint NOI Regarding Light-duty Vehicle Standards for the 2017-2025 Model Years

John German, ICCT, EIA Energy Conference, April 26, 2011

Lightweight materials offer great potential

Material composition of lightweight vehicle body

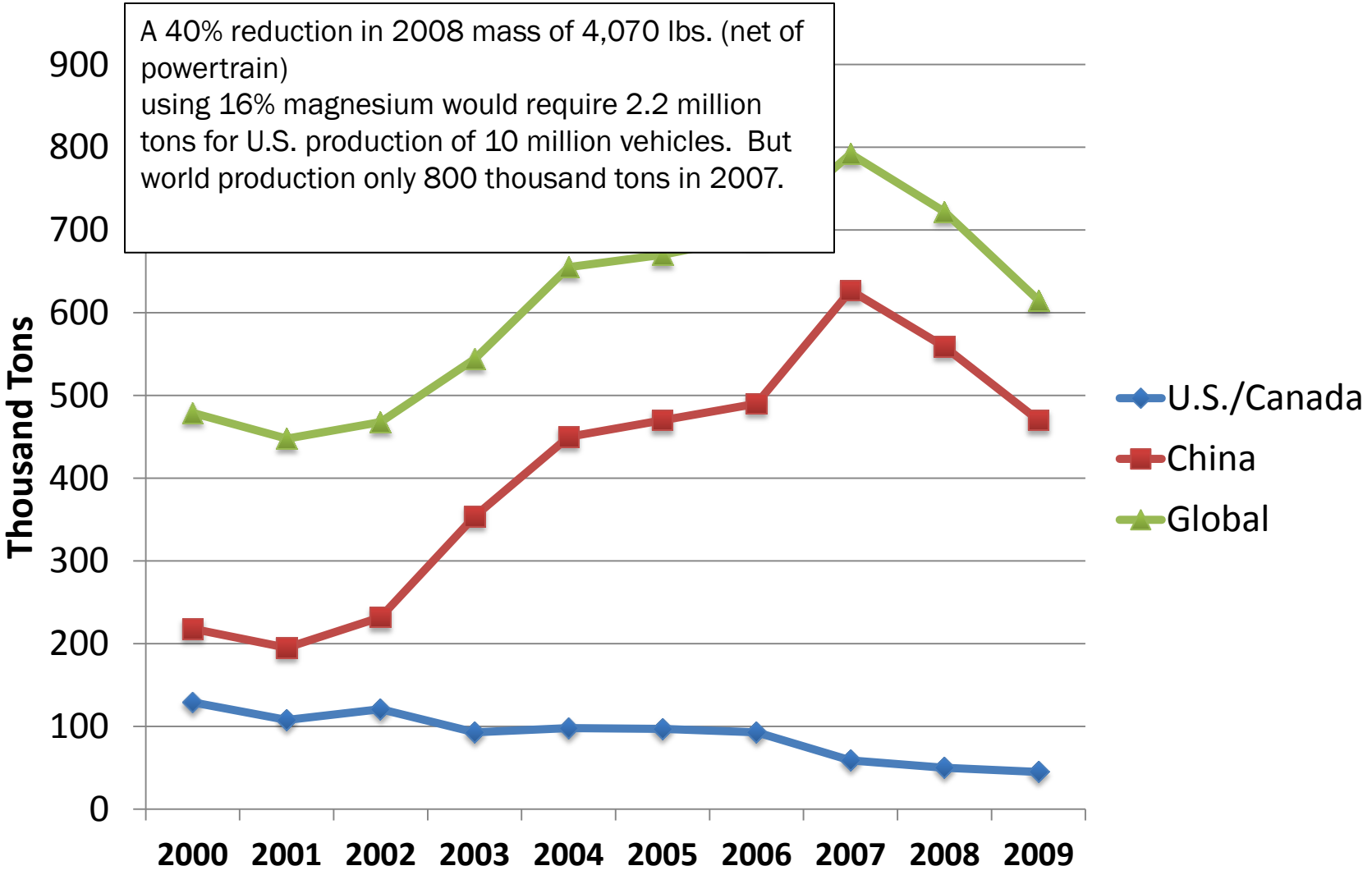


Also incremental improvements in aerodynamics and tire rolling resistance

John German, ICCT, EIA Energy Conference, April 26, 2011

Primary Magnesium Production

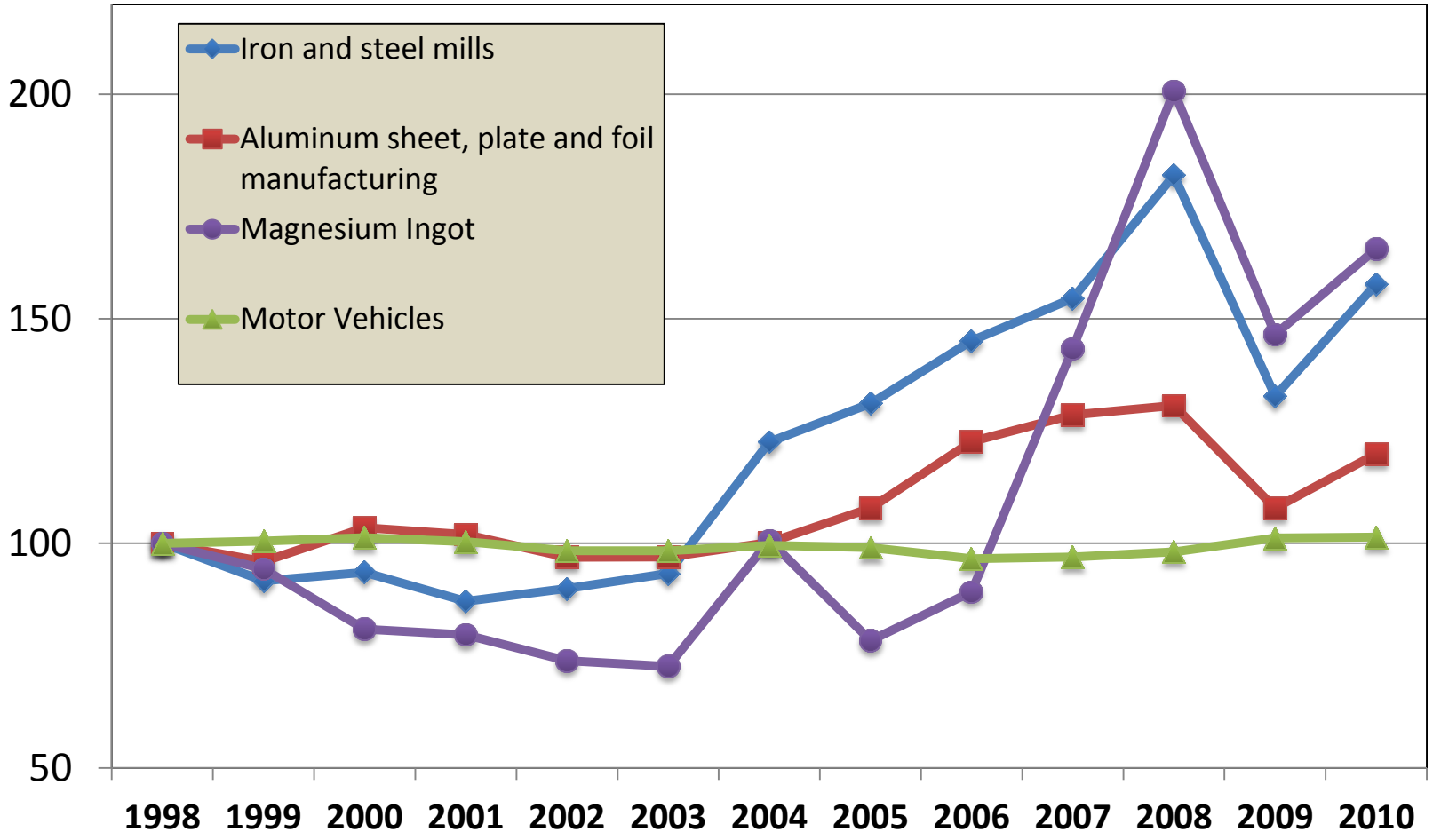
A 40% reduction in 2008 mass of 4,070 lbs. (net of powertrain)
using 16% magnesium would require 2.2 million tons for U.S. production of 10 million vehicles. But world production only 800 thousand tons in 2007.



Source: International Magnesium Association

Material and Vehicle Price Indexes

(Producer Price Index, 1998 = 100)



Source: Bureau of Labor Statistics, U.S. Geological Survey

Technology Pathways
(Intermediate, Mid-size Vehicle)

Pathway	Source of Estimate	Technology Description	Reduction in Consumption Improvement	2008 Total Estimated Incremental RPE	Annual % Cost Reduction (5 yr)	2025 Total Incremental RPE (5 year)
1) Spark Ignited	NAS	DCT, GDI, Turbo & Downsize, 5% mass	29.0%	$2,159	0.5%	$2,105
2) SI Extended Mass	NAS/CAR	(Above plus:) 15% mass (10% addn. mass)	37.5%	$3,089	0.5%	$3,012
3) SI Extended Stop/Start	NAS/CAR	(Above plus:) stop/start	40.0%	$3,974	0.6%	$3,855
4) Compression Ignited	NAS	CI, DCT, 5% mass	37.5%	$5,905	0.5%	$5,757
5) CI Extended Mass	NAS/CAR	(Above with 15% mass (10% addn. mass)	46.0%	$6,835	0.5%	$6,664
6) Full Hybrid	NAS	Power Split, 5% Mass	43.9%	$6,027	2.2%	$5,364
7) Full Hybrid - Extended	NAS/CAR	(Above with 15% mass (10% addn. mass)	52.4%	$6,957	1.9%	$6,296
8) Hybrid - Strong	NAS/CAR	Series PHEV 40, 15% mass (2009)	2.5 (250%)	$14,156	2.1%	$12,670
9) Electric Vehicle	CAR/EPA/ NAS	BEV 75, 10% mass, 27kwh ($300/kwh in 2025)	6 (600%)			$10,584

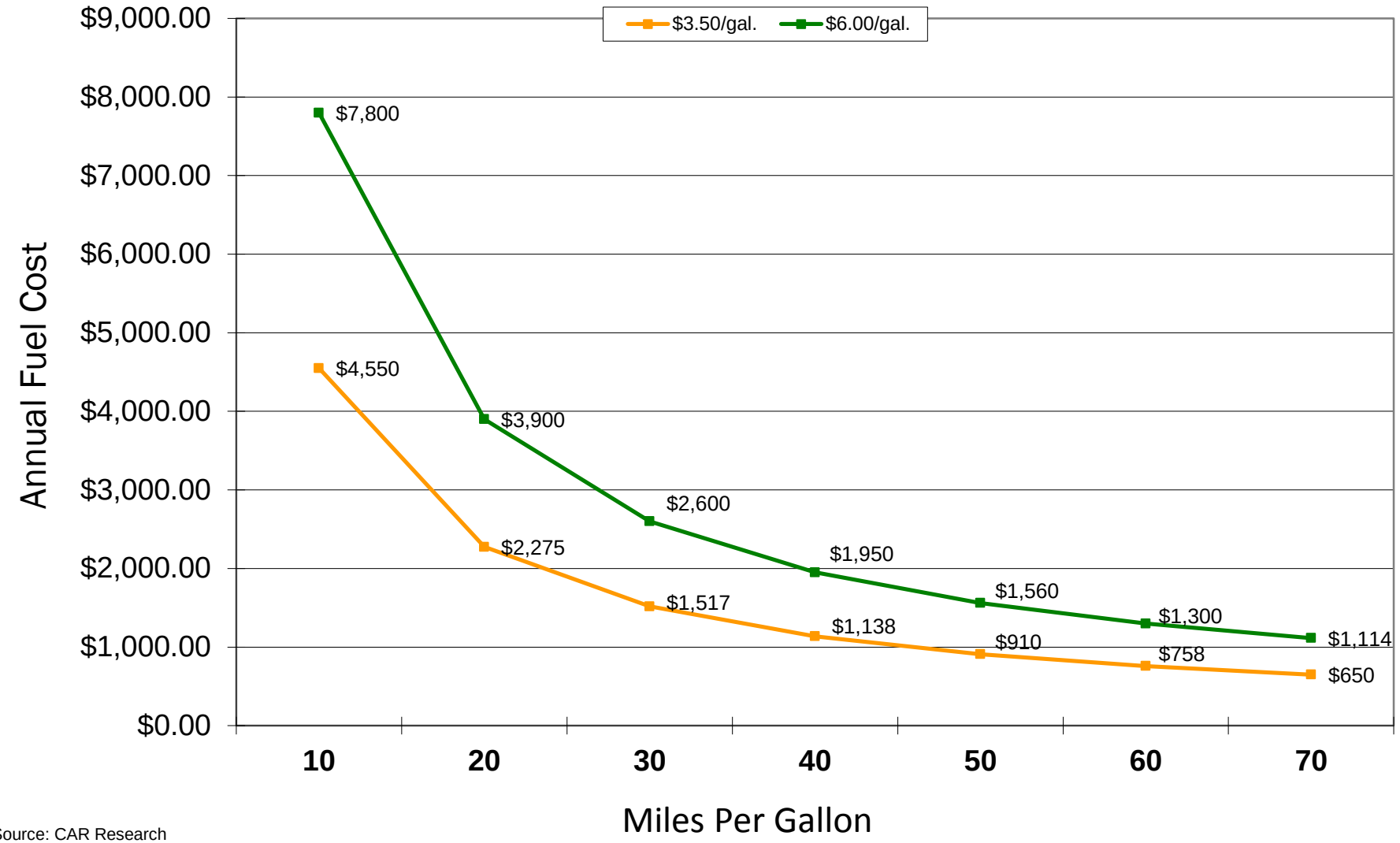
FE Technology Segmentation

	MPG Target: 47 MPG Real: 37.6		MPG Target: 51 MPG Real: 40.8		MPG Target: 56 MPG Real: 44.8		MPG Target: 62 MPG Real: 49.6	
Pathway	Share	Weighted cost	Share	Weighted cost	Share	Weighted cost	Share	Weighted cost
1) Spark Ignited	1.5%	$32	0.0%	$0	0.0%	$0	0.0%	$0
2) SI Extended Mass	80.0%	$2,409	0.0%	$0	0.0%	$0	0.0%	$0
3) SI Extended Stop/Start	0.0%	$0	68.5%	$2,641	36.0%	$1,388	26.9%	$1,038
4) Compression Ignited	0.0%	$0	0.0%	$0	0.0%	$0	0.0%	$0
5) CI w/mass reduction	8.1%	$540	8.1%	$540	8.1%	$540	8.1%	$540
6) Hybrid - Medium	0.0%	$0	0.0%	$0	0.0%	$0	0.0%	$0
7) Hybrid - Medium Extended	8.4%	$529	13.4%	$846	35.7%	$2,250	0.0%	$0
8) Hybrid - Strong	1.1%	$139	9.1%	$1,149	19.3%	$2,441	64.1%	$8,117
9) Electric Vehicle	0.9%	$95	0.9%	$95	0.9%	$95	0.9%	$95
	100.0%	$3,744	100.0%	$5,270	100.0%	$6,714	100.0%	$9,790

Two important assumptions:

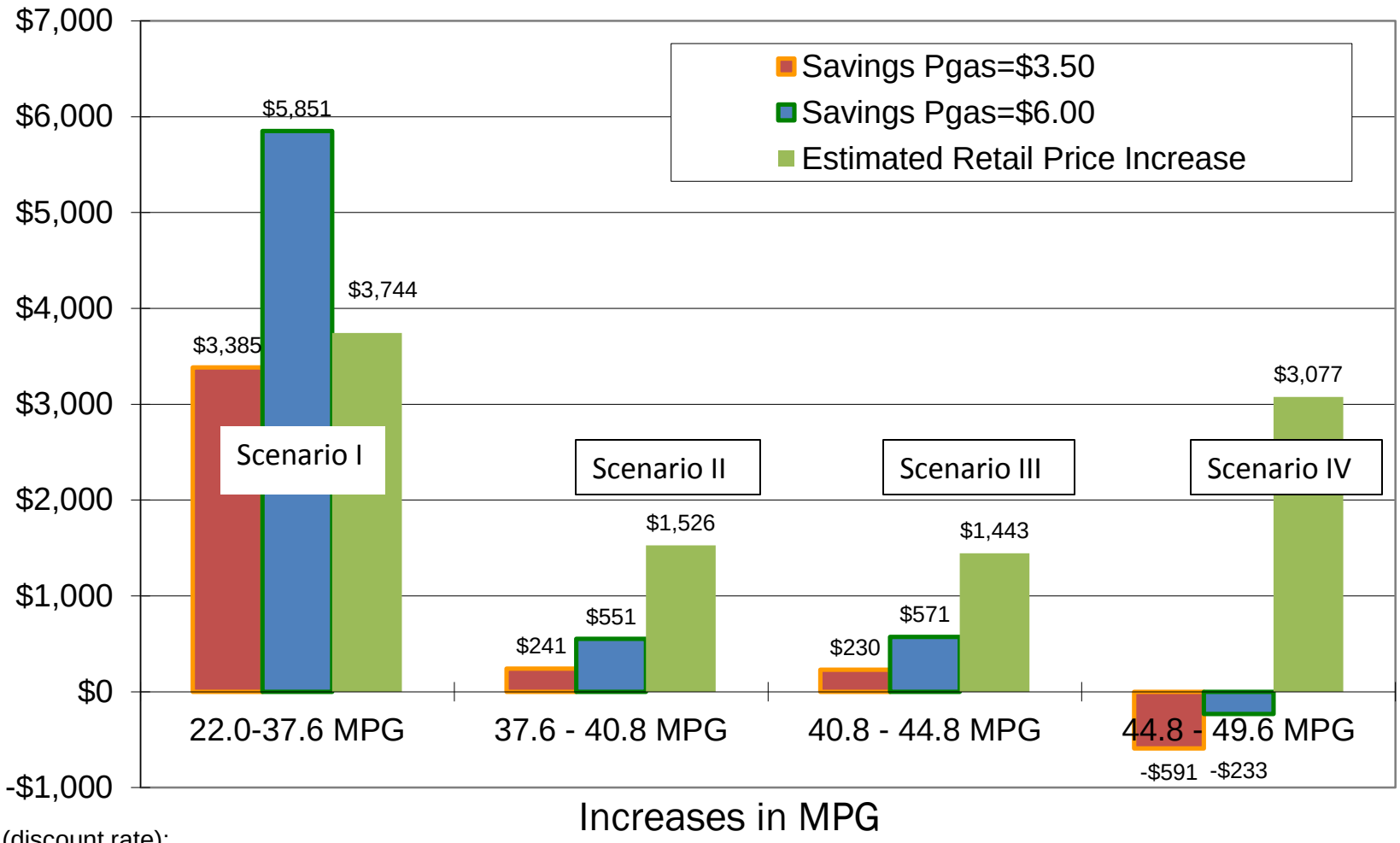
- Unknown impact from A/C credits (to lower CAFE requirements)
- BEV forecast by J.D. Power is 0.9% of market for 2020

Average Fuel Expenditures at Increasing MPG Levels: Holding Annual Average VMT= 13,000



Source: CAR Research

Present Value of Fuel Savings from MPG Increases (Netted for Electricity Cost) & Estimated Average Retail Price Increase to Improve MPG



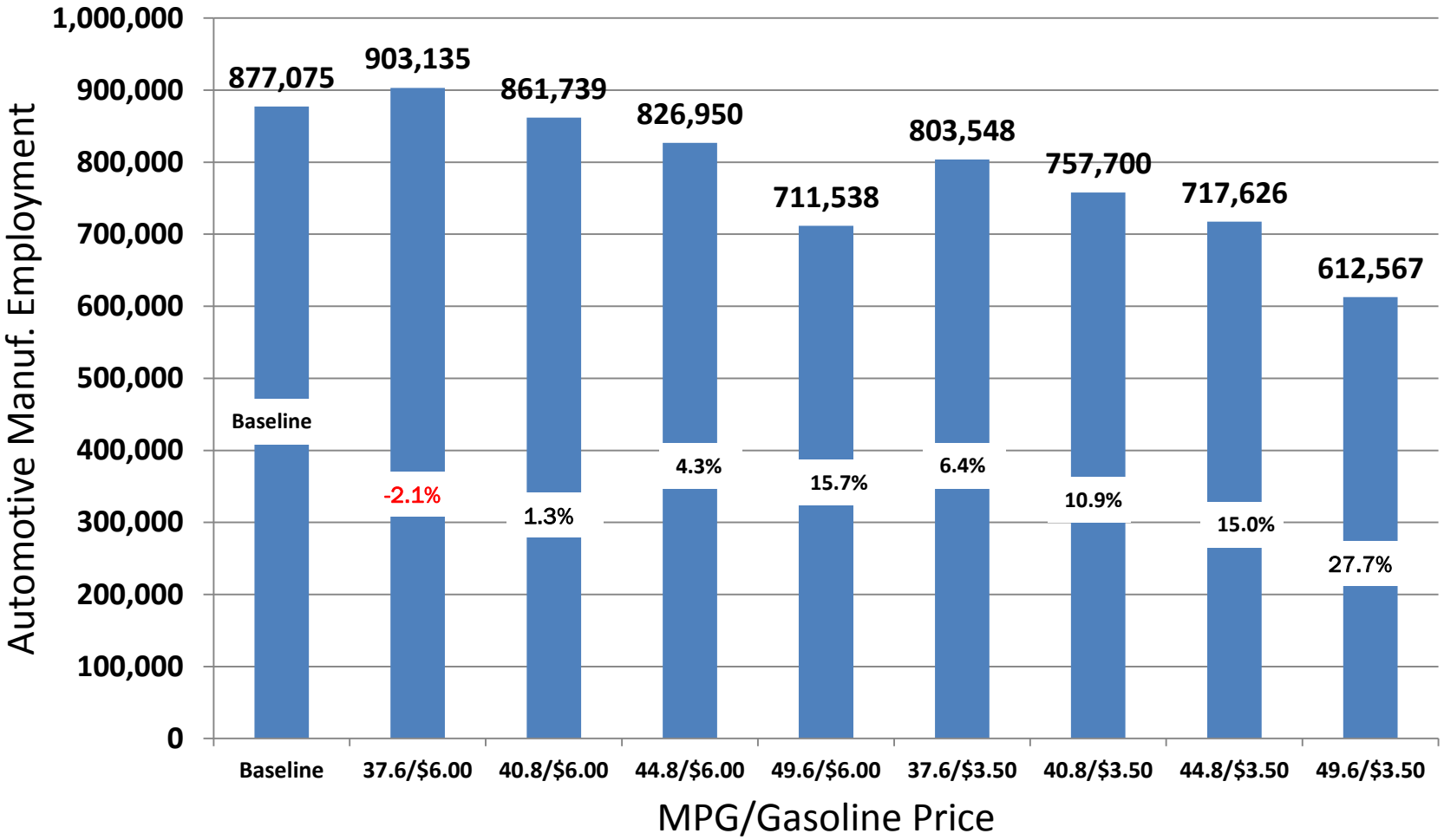
r=10% (discount rate);
Rebound rate=10%;
Fuel Savings valued over 5 years
VMT average years 1-5: Scenario (S) I=13,737; SII=13,923; SIII=14,157miles; SIV= 14,436

Source: CAR Research, DOT NHTS 2009

Effect on U.S. Vehicle Sales, Production and Automotive Employment of Higher Retail and Net Vehicle Prices due to Higher Fuel Economy and Safety

		Net Price Increase							
	Baseline	-2.1%	1.3%	4.3%	15.7%	6.4%	10.9%	15.0%	27.7%
Net MV Exp.(Billion $)	713	718	709	701	669	695	682	671	636
Total MV Exp. (Billion $)	713	867	864	847	803	771	760	748	692
Gross Vehicle Price (2009$)	$28,966	$34,210	$35,736	$37,180	$40,256	$34,210	$35,736	$37,180	$40,256
Gross Vehicle Price (2025$)	$39,764	$46,963	$49,058	$51,040	$55,263	$46,963	$49,058	$51,040	$55,263
Net Vehicle Price (2025$)	$39,764	$38,932	$40,271	$41,469	$46,012	$42,316	$44,080	$45,747	$50,782
Light Vehicle Sales (Million Units)	17.9	18.5	17.6	16.9	14.5	16.4	15.5	14.7	12.5
Light Vehicle Production (Million Units)	10.8	11.1	10.6	10.1	8.7	9.9	9.3	8.8	7.5
Automotive Employment	877,075	903,135	861,739	826,950	711,538	803,548	757,700	717,626	612,567
MPG/GAS Price	22.0/n.a.	37.6/$6.00	40.8/$6.00	44.8/$6.00	49.6/$6.00	37.6/$3.50	40.8/$3.50	44.8/$3.50	49.6/$3.50

Net Vehicle Price Change Percentages and Automotive Manufacturing Employment



Conclusions

- Sales/Production/Employment will increase as economy slowly improve
- Vehicles fleet at record age – replacement sales must happen
- Long run threat from extreme fuel economy mandates
- May shrink industry sale, production, and employment