

An aerial photograph of a dry, brown landscape, likely a desert or semi-arid region. The terrain is characterized by a dense network of roads and tracks, some of which are light-colored, suggesting they are unpaved. The landscape is rugged and hilly, with some areas appearing more eroded than others. In the lower right quadrant, there is a small cluster of buildings, possibly a town or a small settlement. The overall color palette is dominated by shades of brown, tan, and beige, with some darker patches of soil or rock.

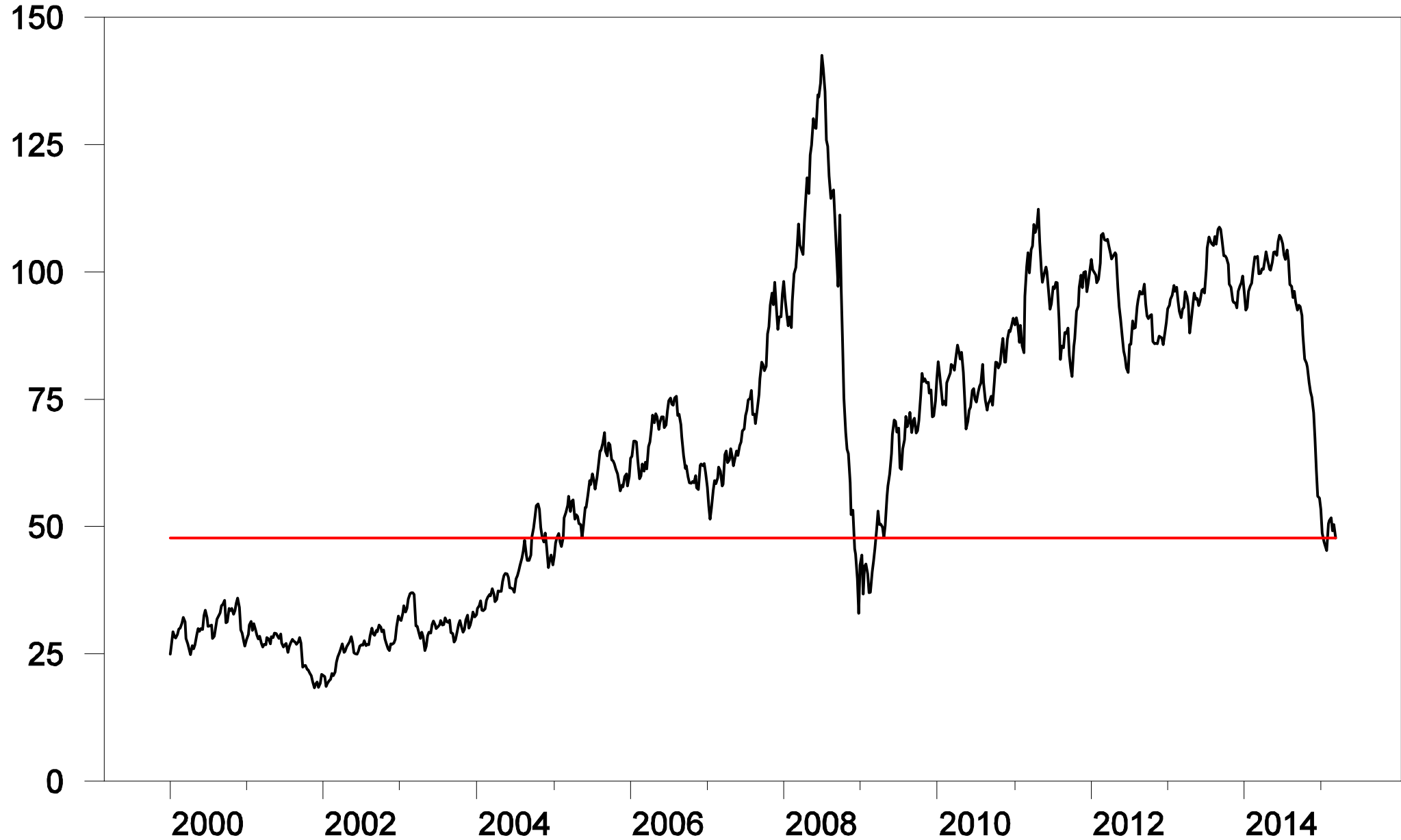
Energy Challenges for the 21st century

James D. Hamilton

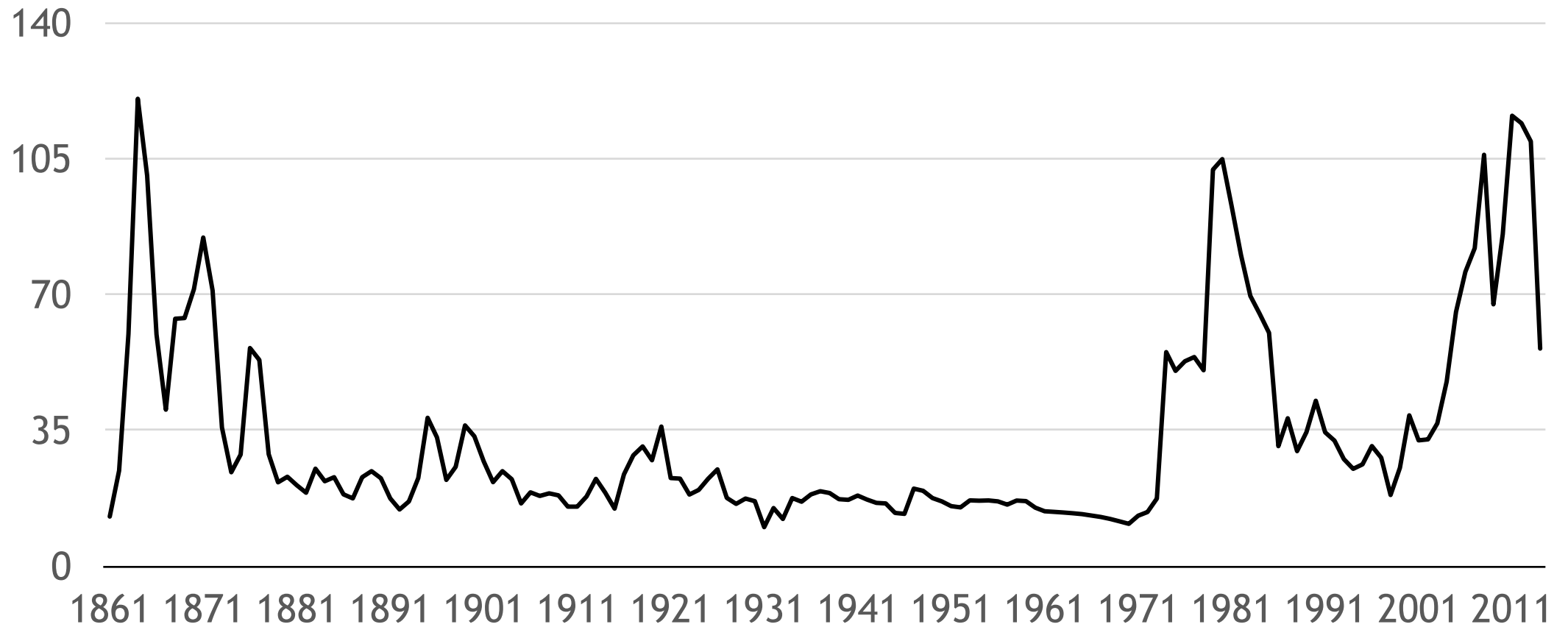
Department of Economics

University of California at San Diego

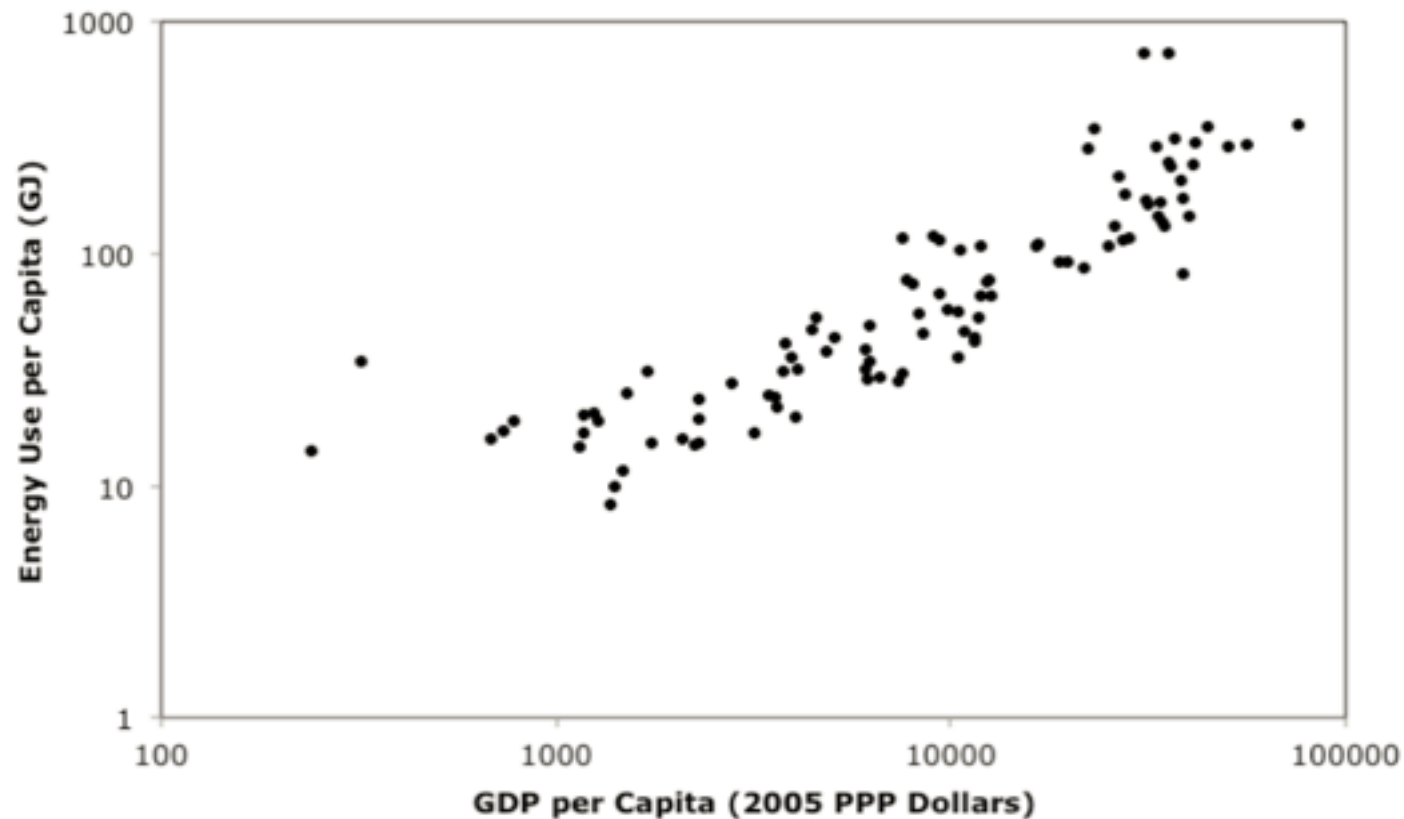
Nominal Price of West Texas Intermediate (\$/barrel)



World real price of oil (2014 \$/barrel, 1861-2014)

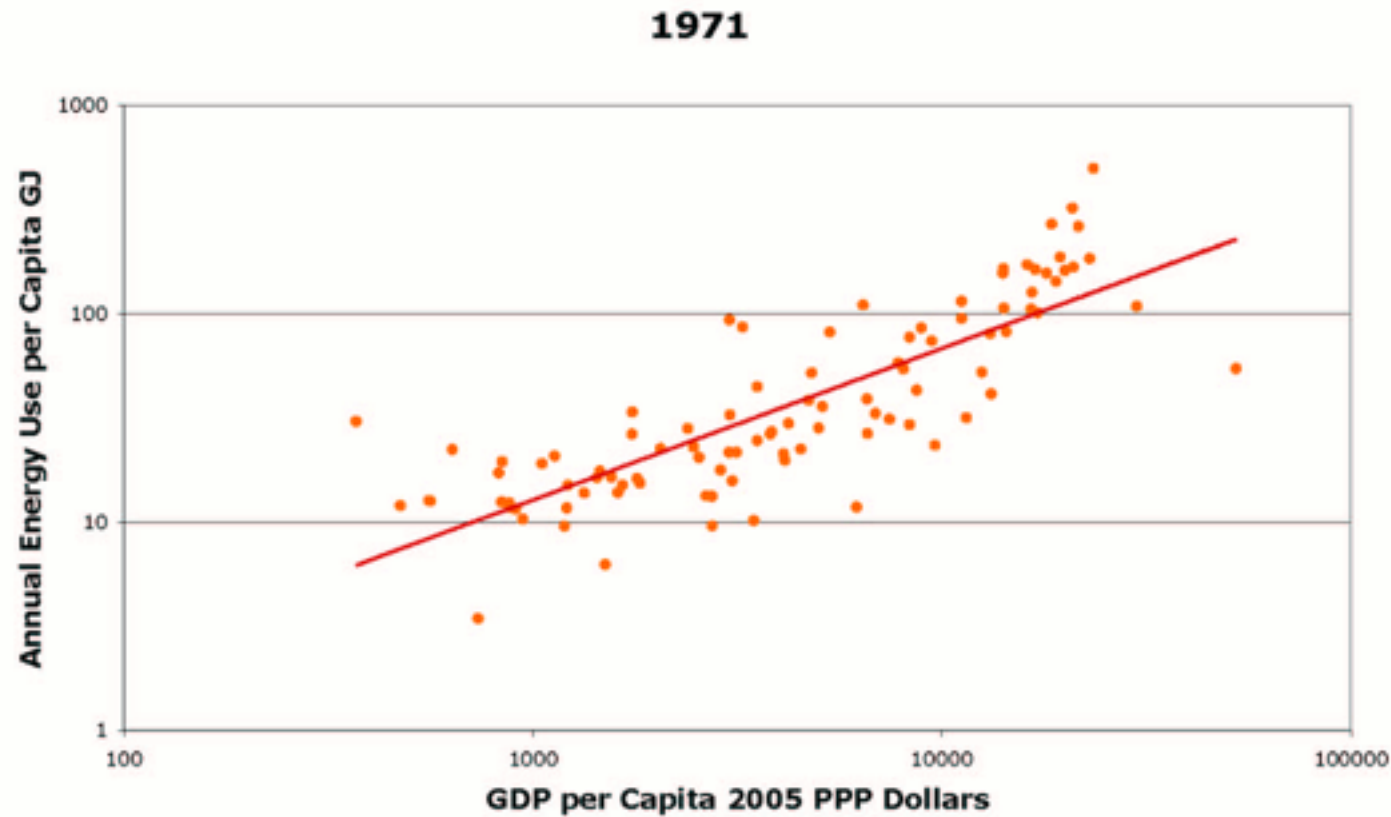


Economic growth is associated with higher energy use



Cross-section scatterplot (log scale) of energy use and GDP per capita for 2010. Source: Csereklyei, Rubio, and Stern (2014).

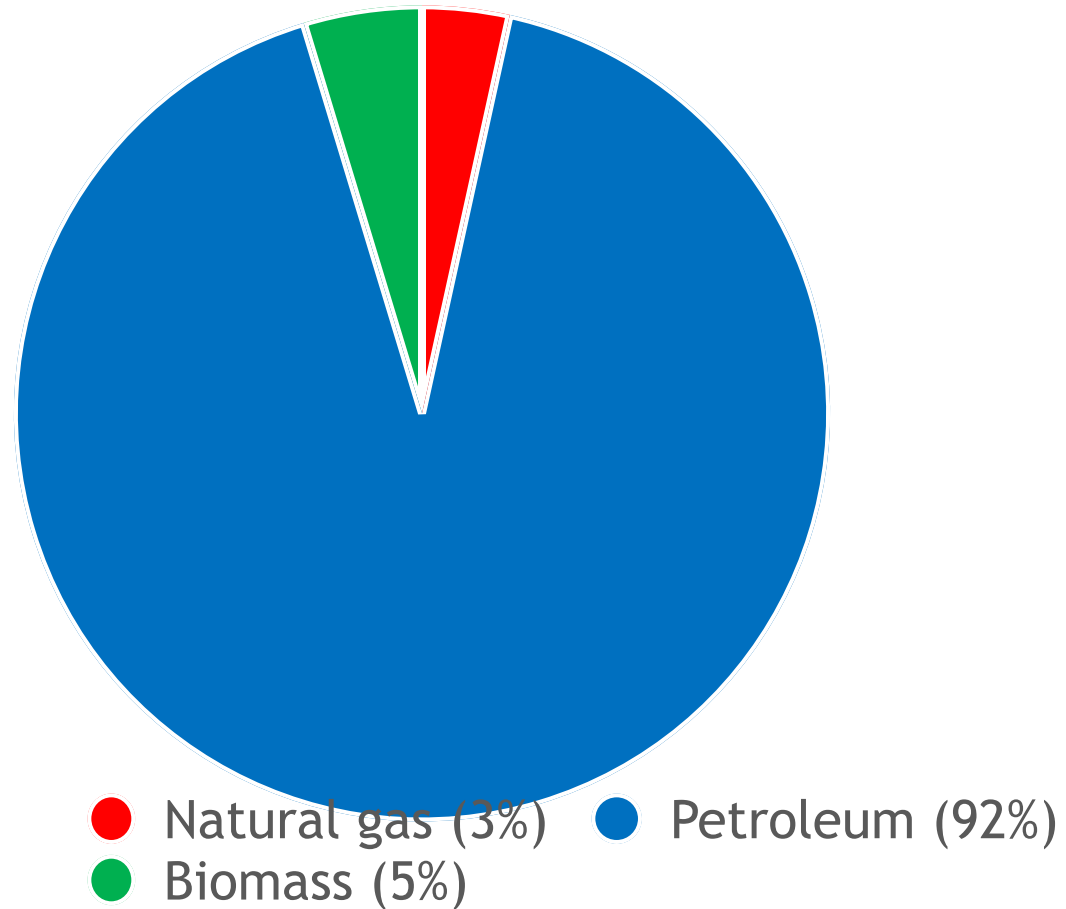
Income elasticity of energy demand is about 0.7



Cross-section scatterplot (log scale) of energy use and GDP per capita for indicated years. Source: David Stern (<http://www.sterndavidi.com/animation.gif>)

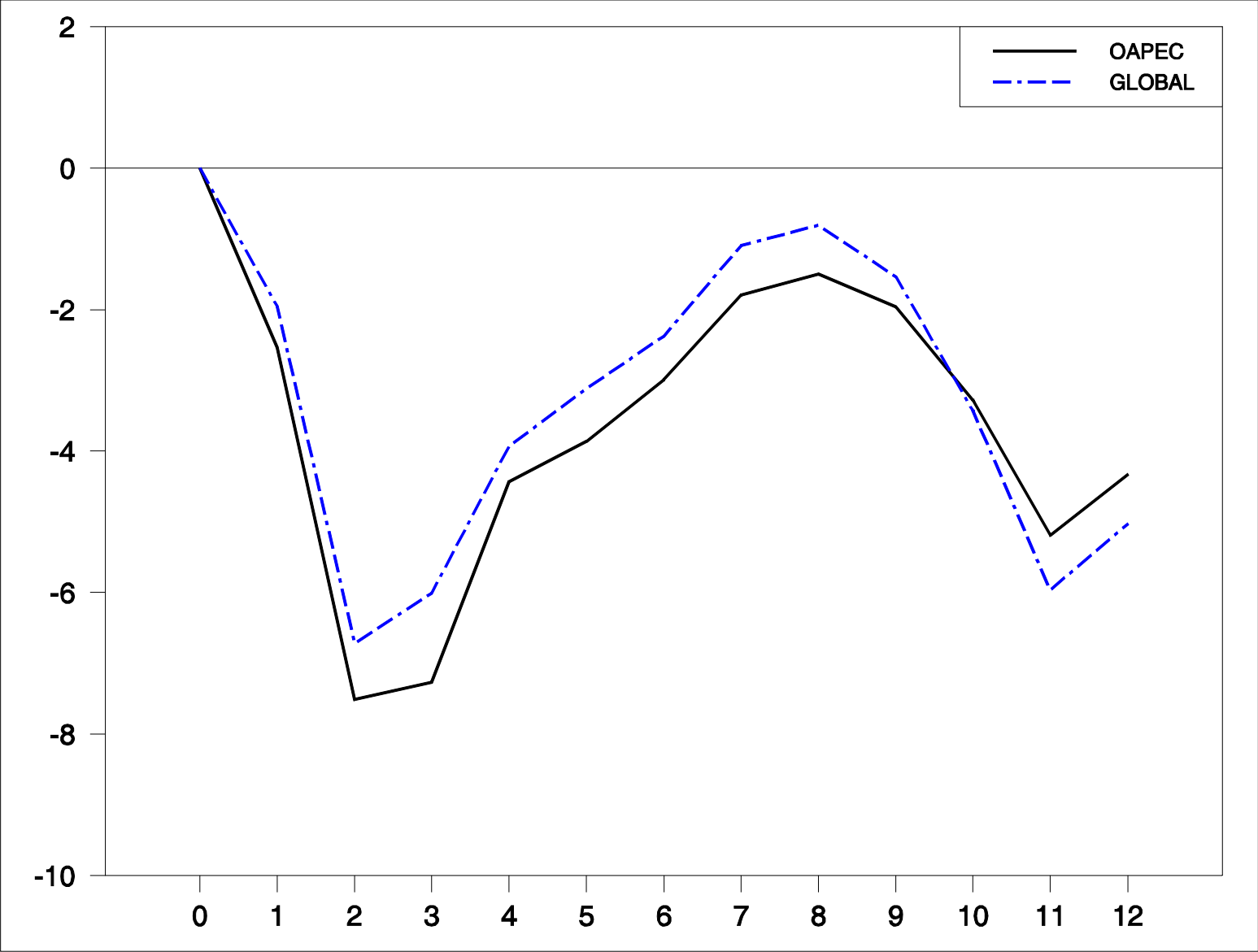
Oil has unique advantages
for transportation

2013 U.S. energy consumption for transportation

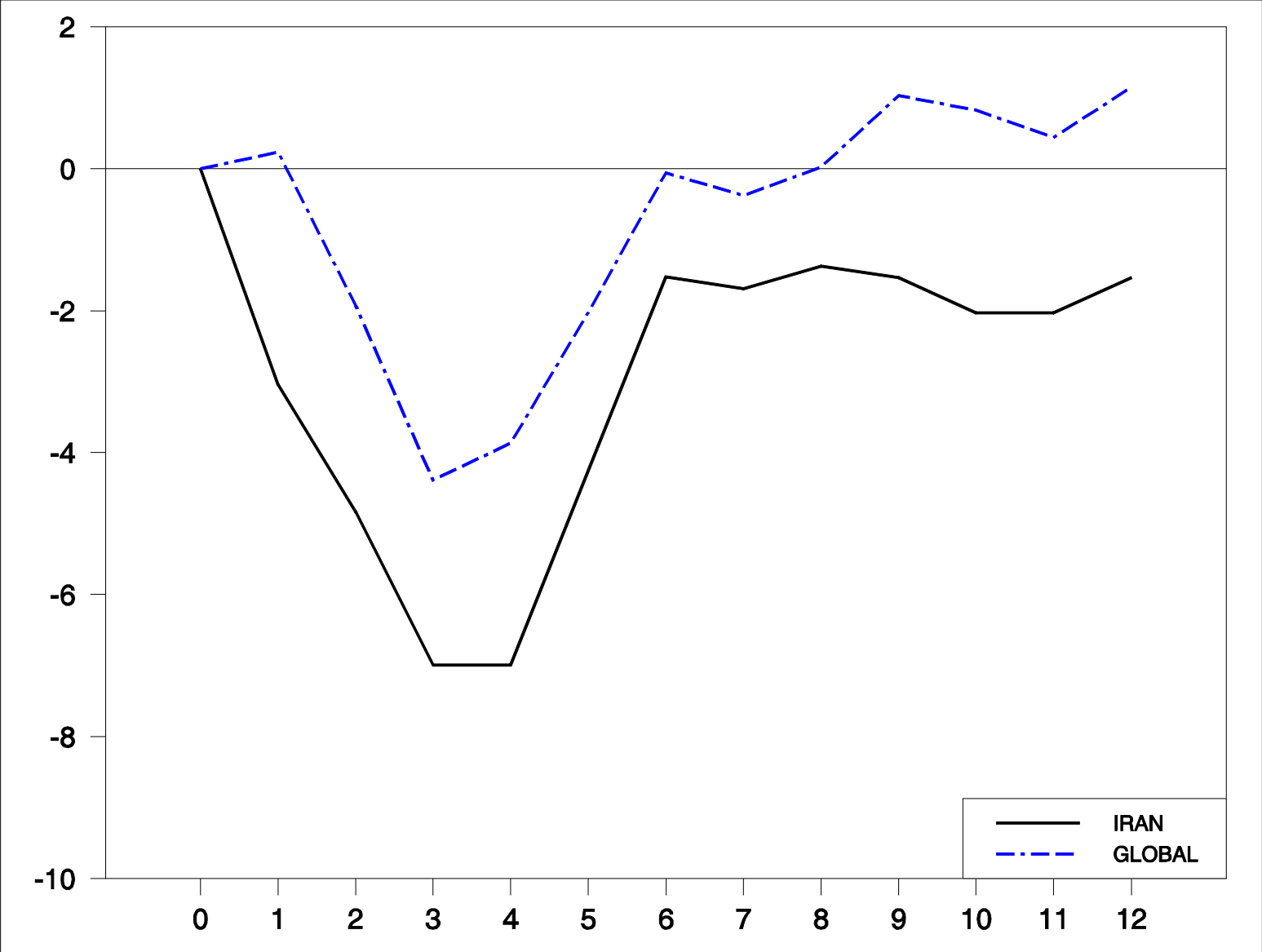


- Question: What would happen if world suddenly had to make due with 5% less oil being produced?

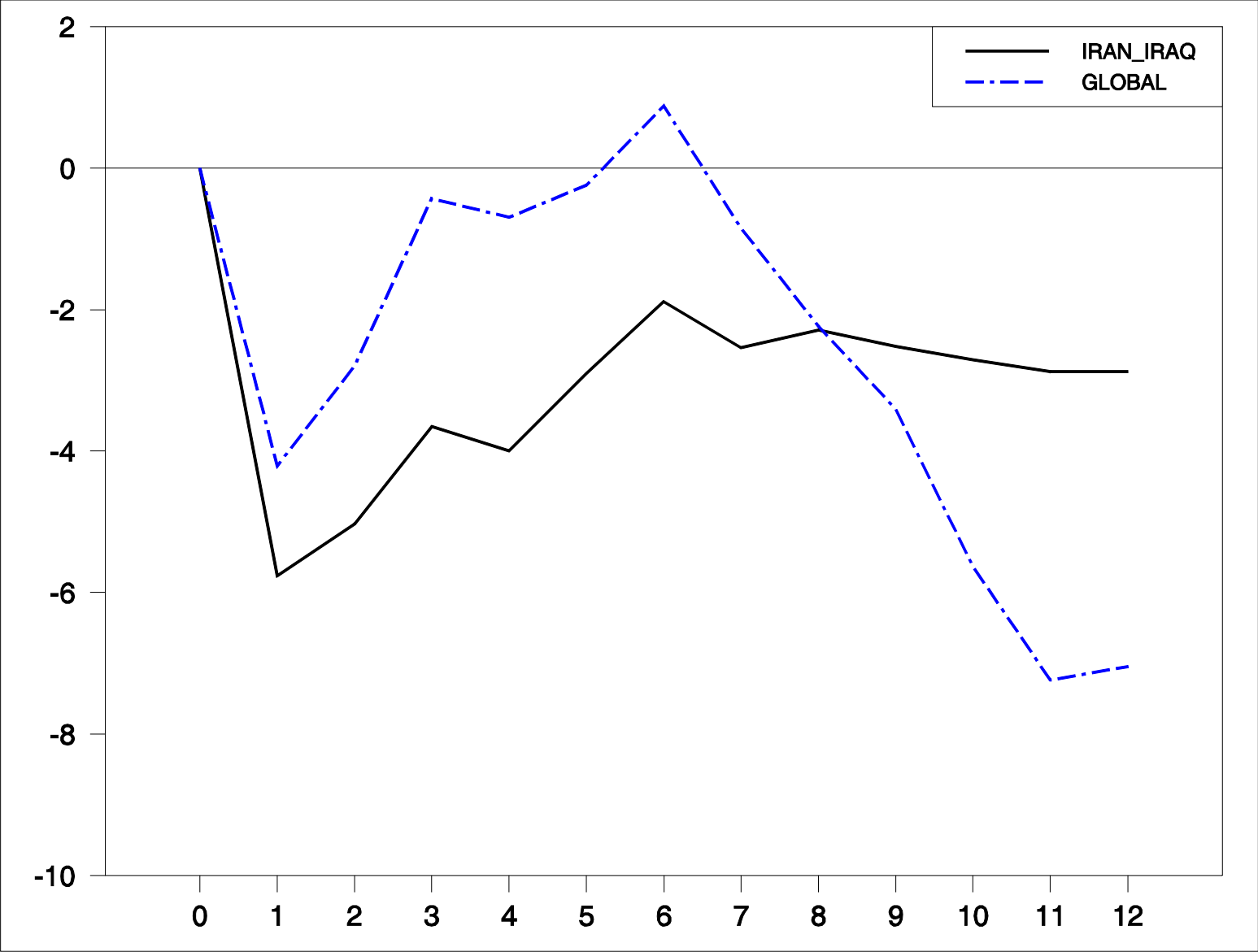
- Question: What would happen if world suddenly had to make due with 5% less oil being produced?
- This experiment has been run a number of times.



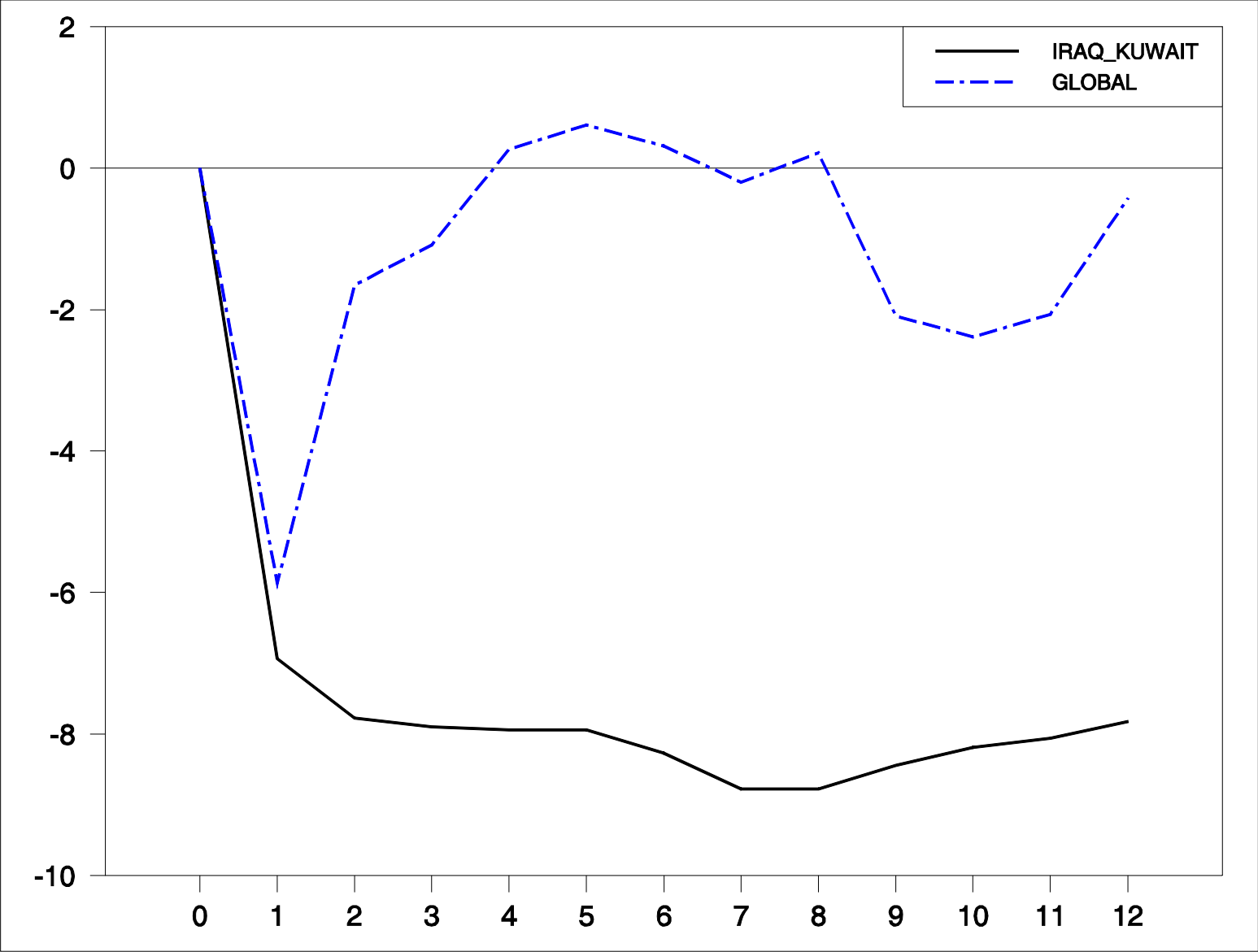
OPEC embargo: Oil production after Sept 1973 Arab-Israeli War.



Iranian revolution: production after Oct 1978



Iran-Iraq War: production after Sept 1980.



First Persian Gulf War: production after Aug 1990.

Major historical oil supply disruptions were followed by recessions

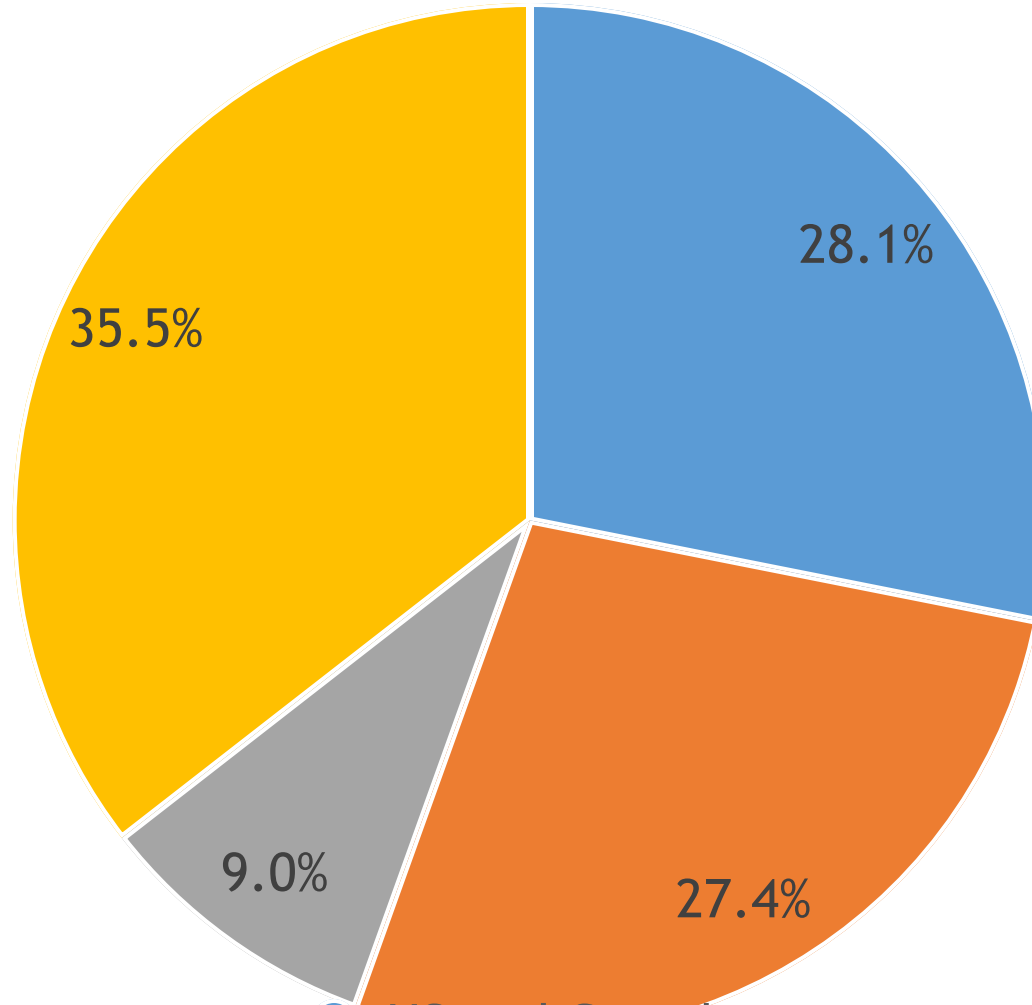
Date	Event	Supply cut (local)	Supply cut (global)	Price Change	Recession Start
Nov 73	OPEC embargo	7%	7%	51%	Dec 73
Nov 78	Iran revolution	7%	4%	57%	Feb 80
Oct 80	Iran-Iraq War	6%	4%	45%	Aug 81
Aug 90	Gulf War I	9%	6%	93%	Aug 90

Challenge for the 21st century: meeting energy needs of emerging economies



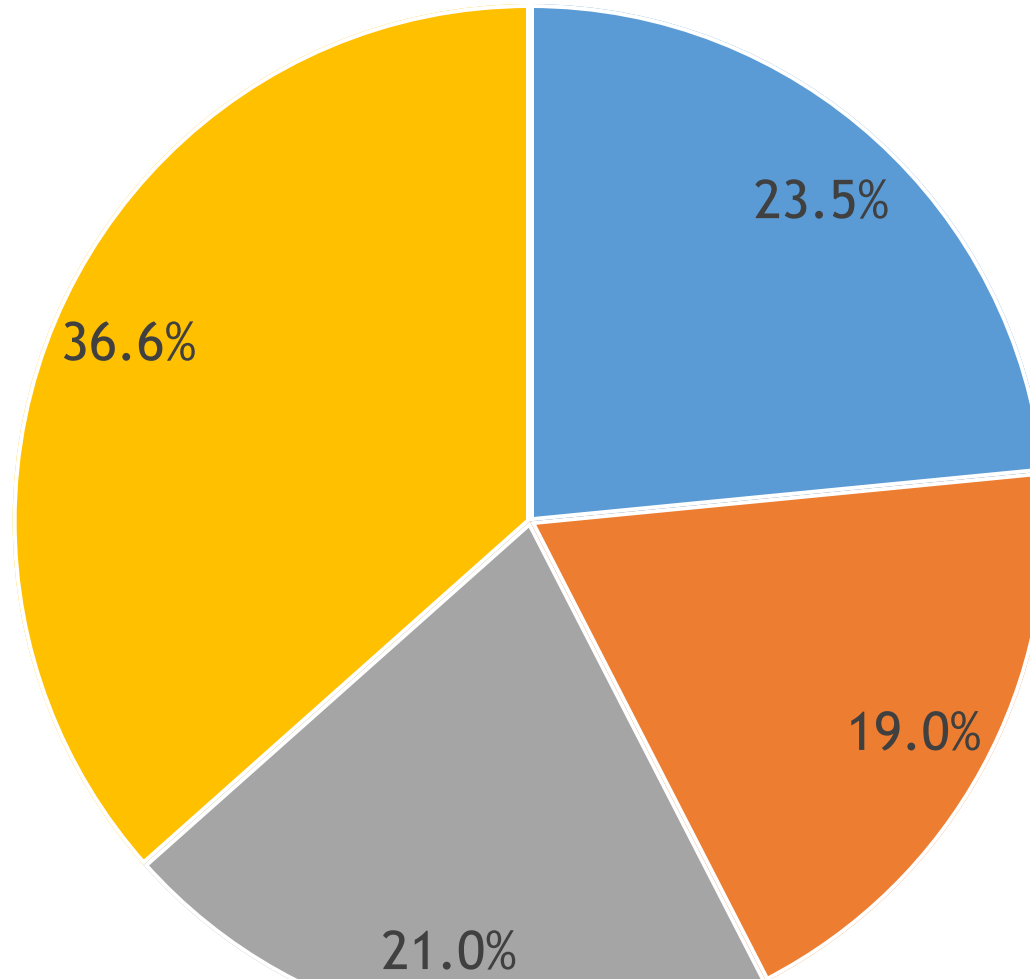
Traffic jam in Beijing, August 2010.

World oil consumption in 1990



- US and Canada
- Europe and Japan
- China, India, Brazil, Korea
- Rest of world

World oil consumption in 2013

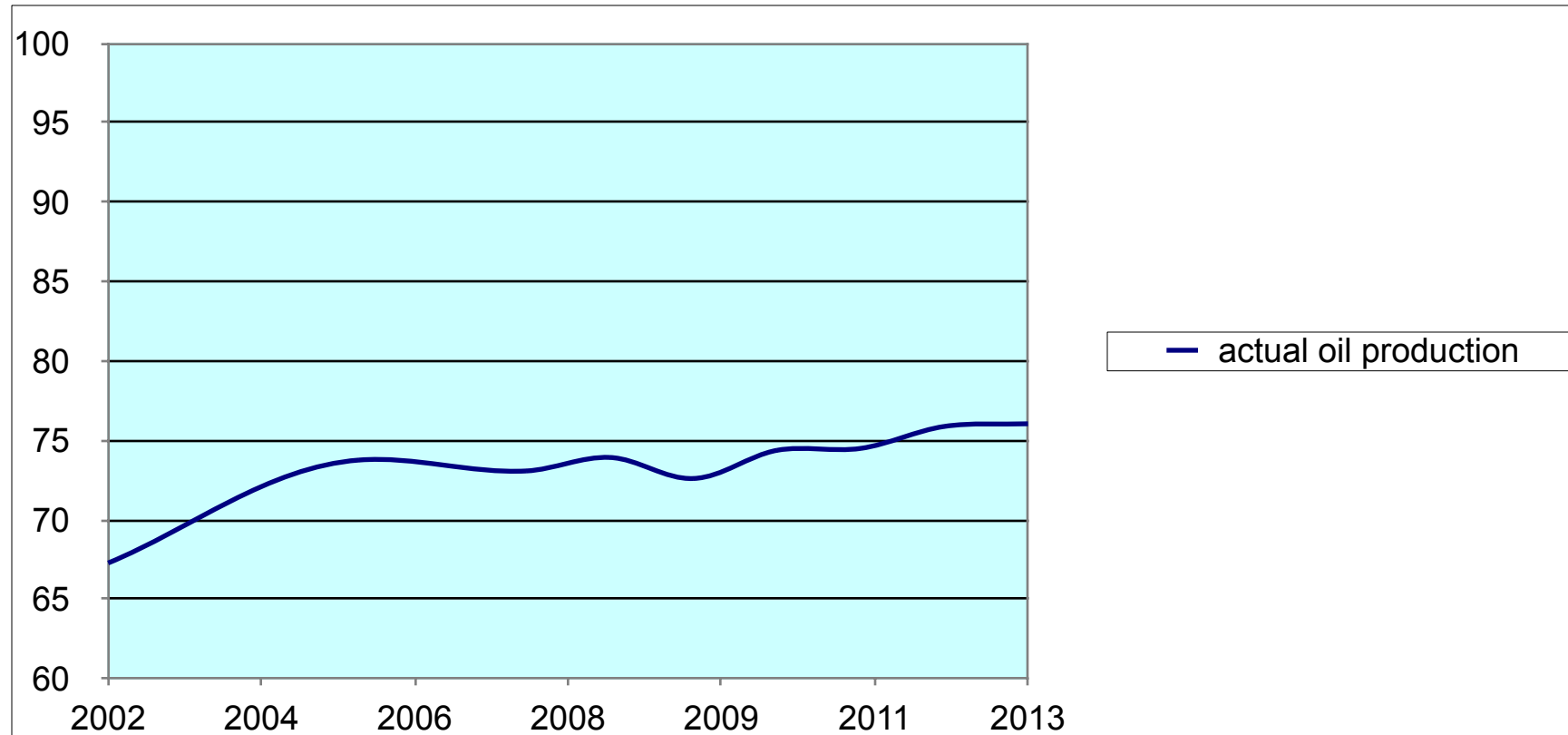


- US and Canada
- Europe and Japan
- China, India, Brazil, Korea
- Rest of world

China's annual compound growth rates

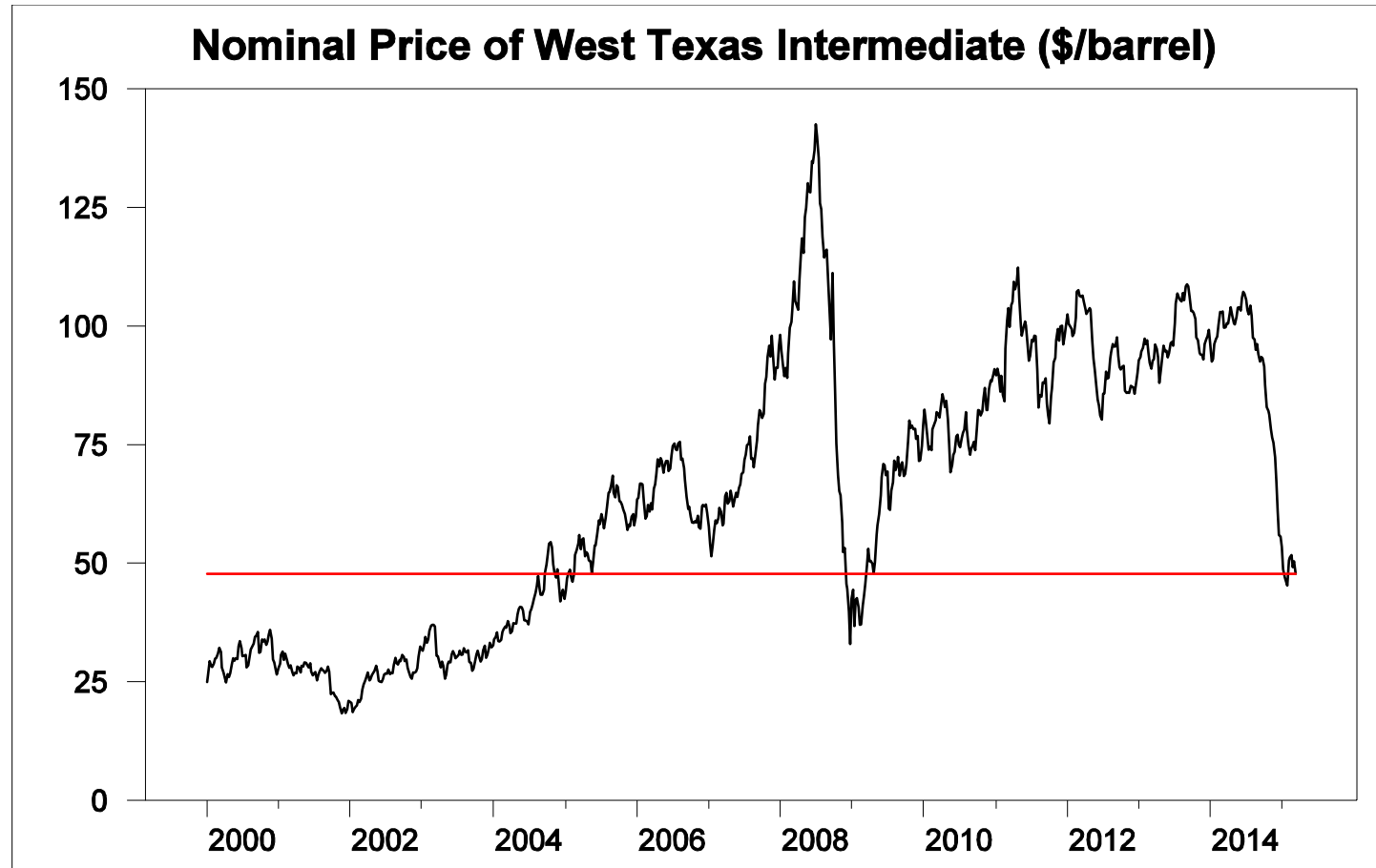
- Real GDP 1990-2012 = 9.8%
 - doubles every 8 years
- Oil consumption 1990-2012 = 6.7%
 - doubles every 11 years
 - 2.3 mb/d in 1990
 - 4.8 mb/d in 2000
 - 10.3 mb/d in 2013
- Real GDP 2012-2019 (IMF forecast) = 6.7%

World field production of crude oil only up 2.3 mb/d
2005-2013 (= 3% increase)



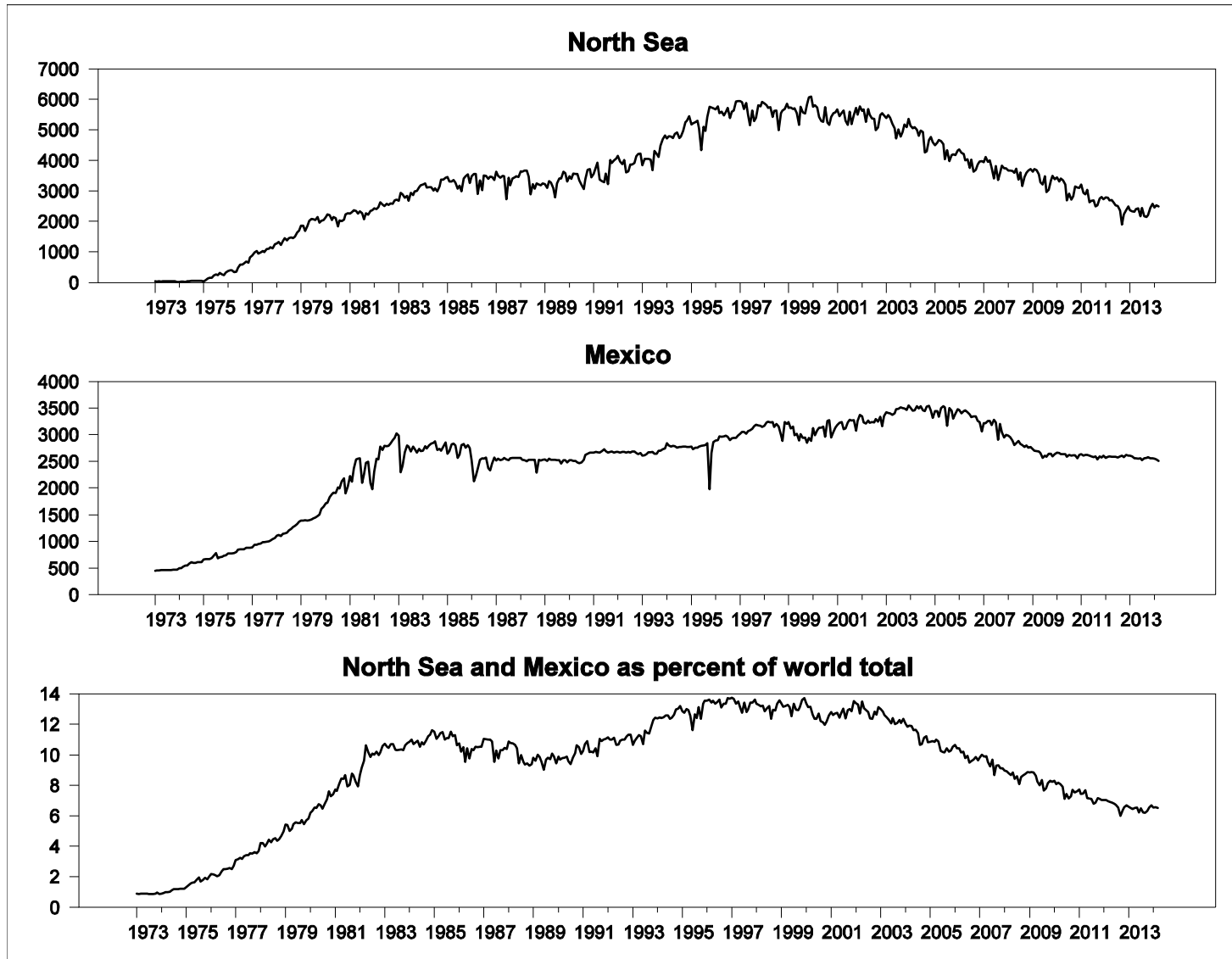
World GDP increased 27.7% from 2005 to 2013

Why did oil prices collapse in 2008-2009?



- Why did oil prices collapse in 2008-2009?
 - Answer: fears that global economy would come crashing down and with it end growth in oil demand.
 - These fears proved to be wrong- world GDP quickly returned to growth and original challenges returned.
- Why did oil production stagnate 2005-2012?

One factor in stagnating world production: declining flows from mature fields

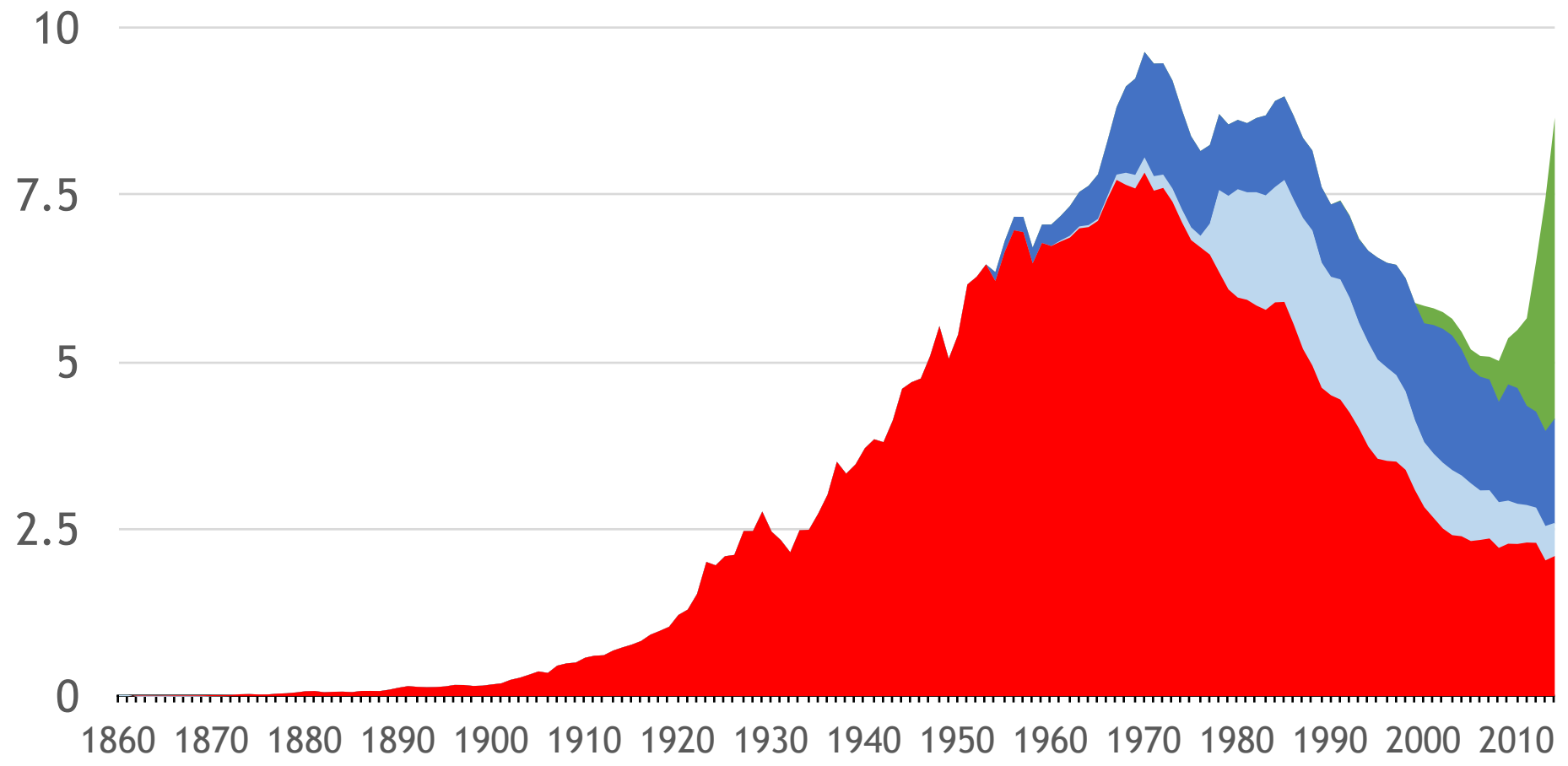


Another factor in stagnating world
production: geopolitical turbulence

Adapted from EIA, “Short Term Energy Outlook”

- Why then did oil prices collapse the last year?
- One answer: phenomenal increase in U.S. production from tight formations.

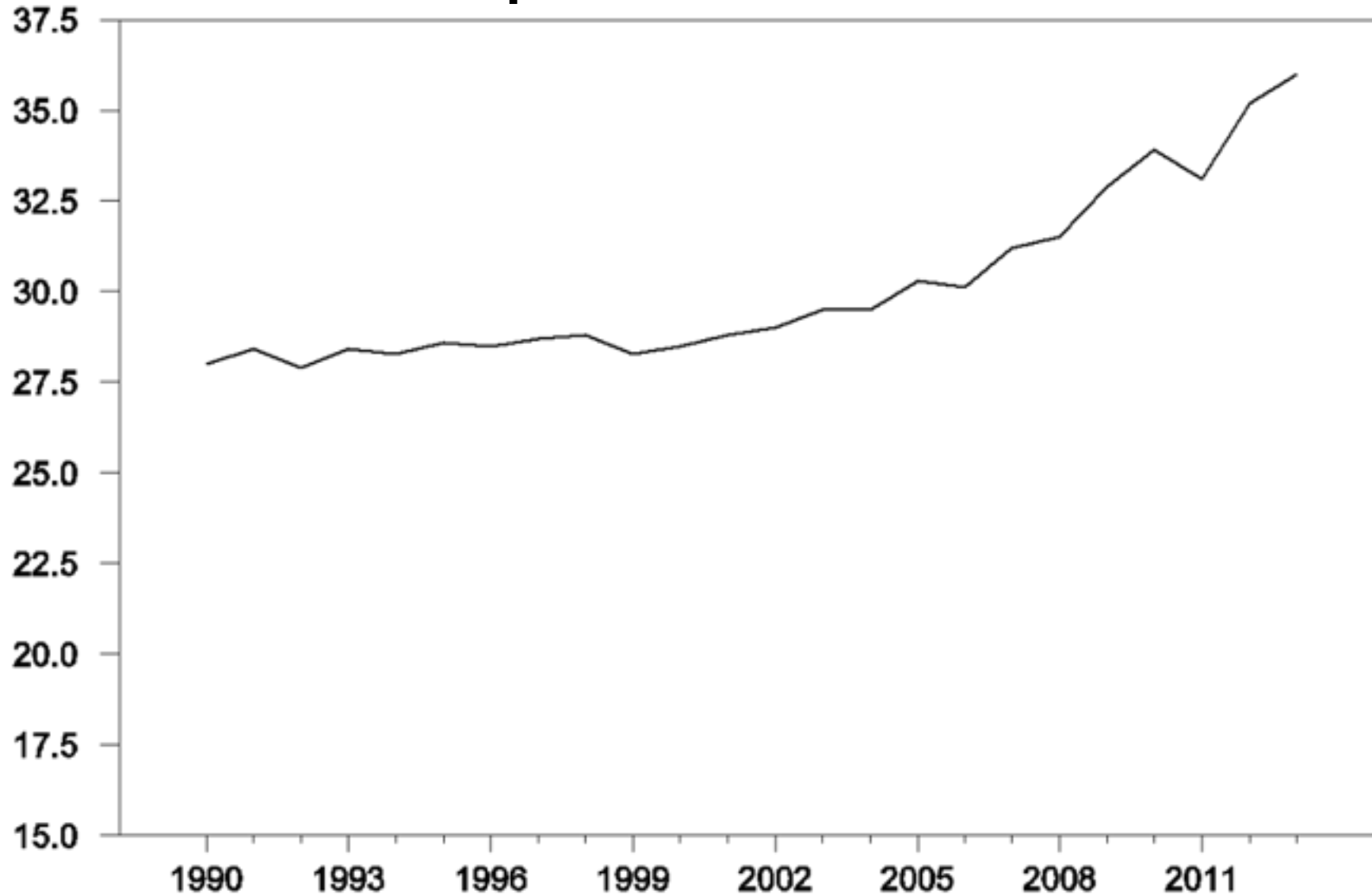
U.S. oil production by source



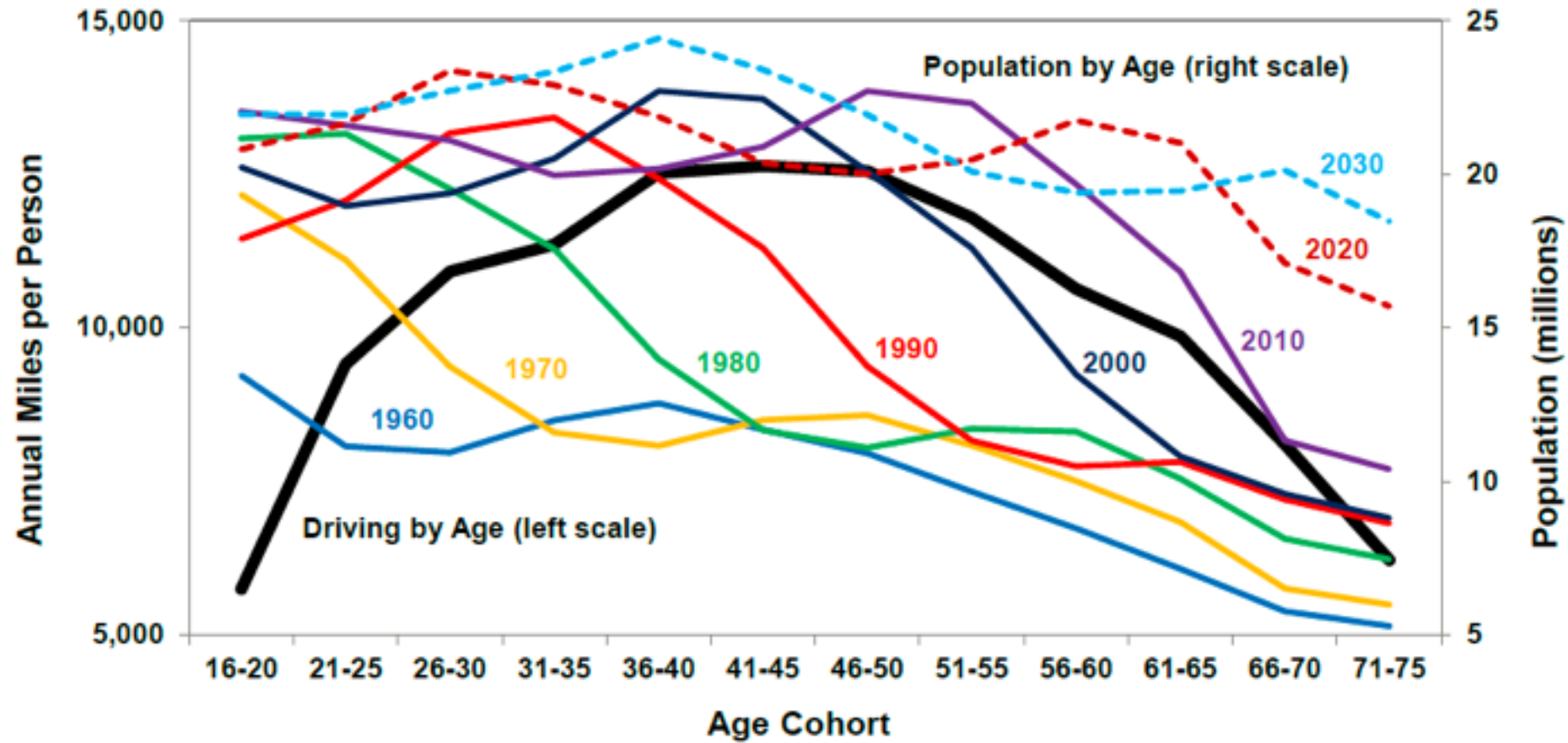
■ lower 48 ■ Alaska ■ offshore
■ tight oil

- In addition to big increases in U.S. production, U.S. consumption continues to decline.
- How did this happen in a growing economy?

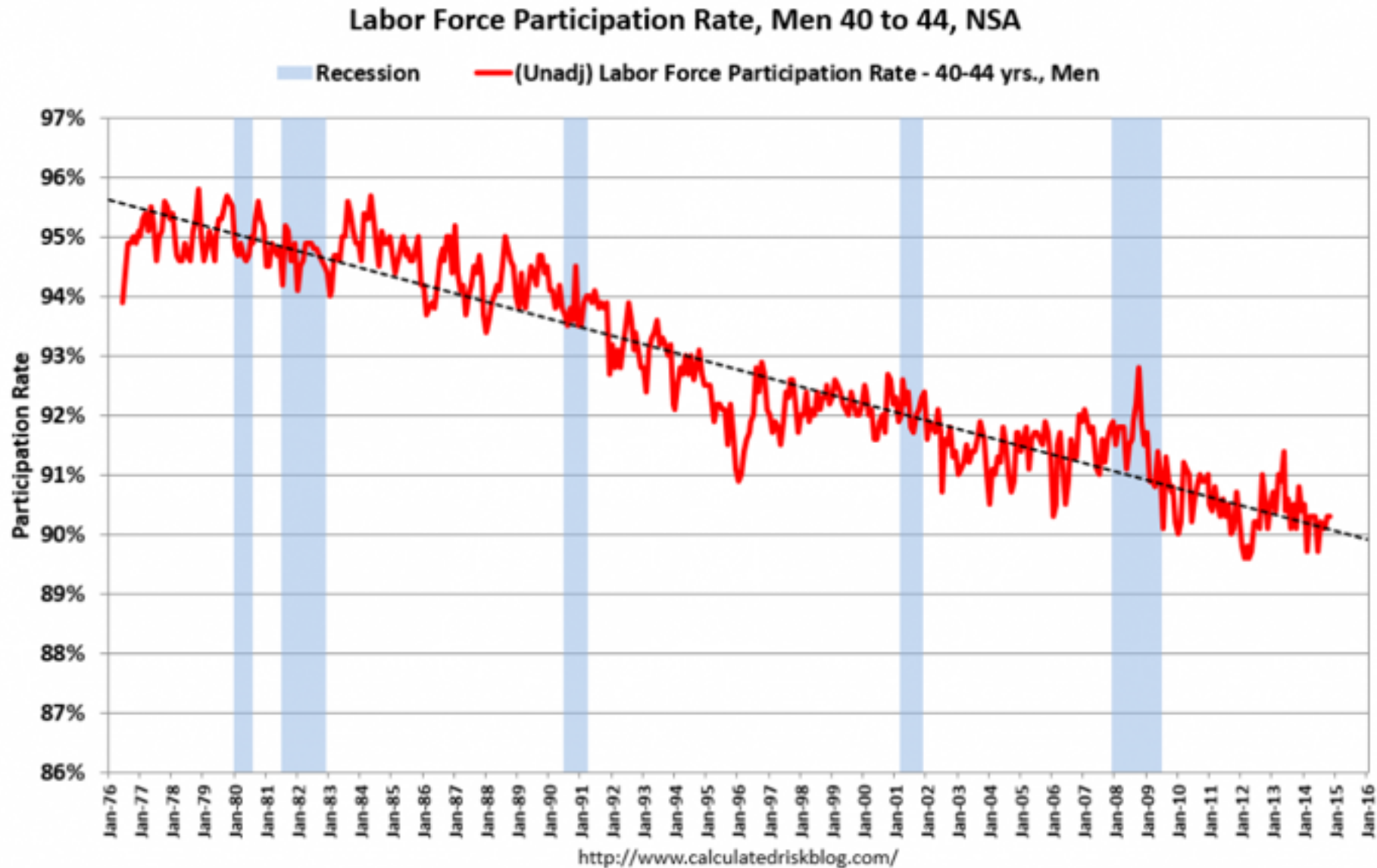
Fuel economy (mpg) of new American cars continues to improve



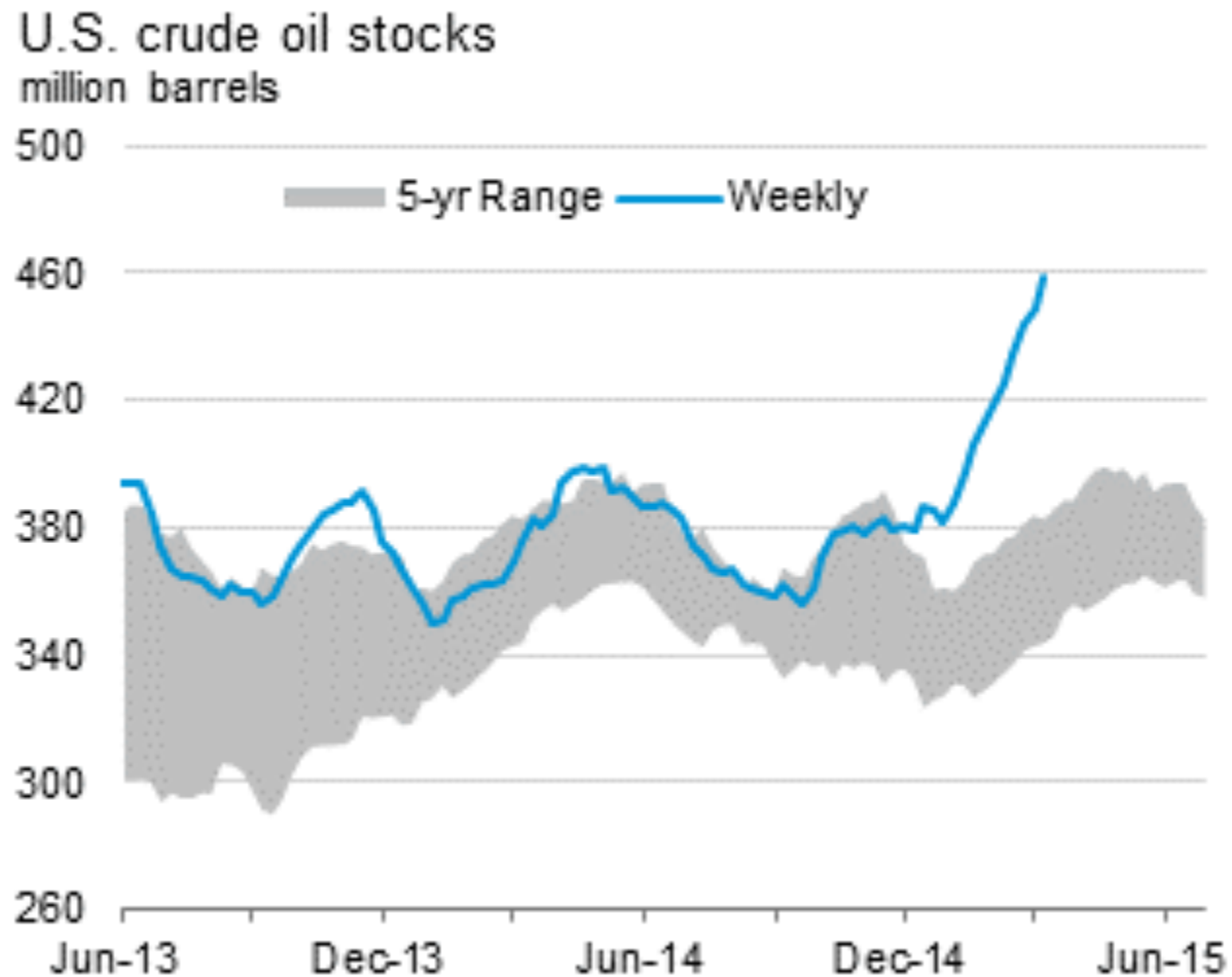
Older people drive less



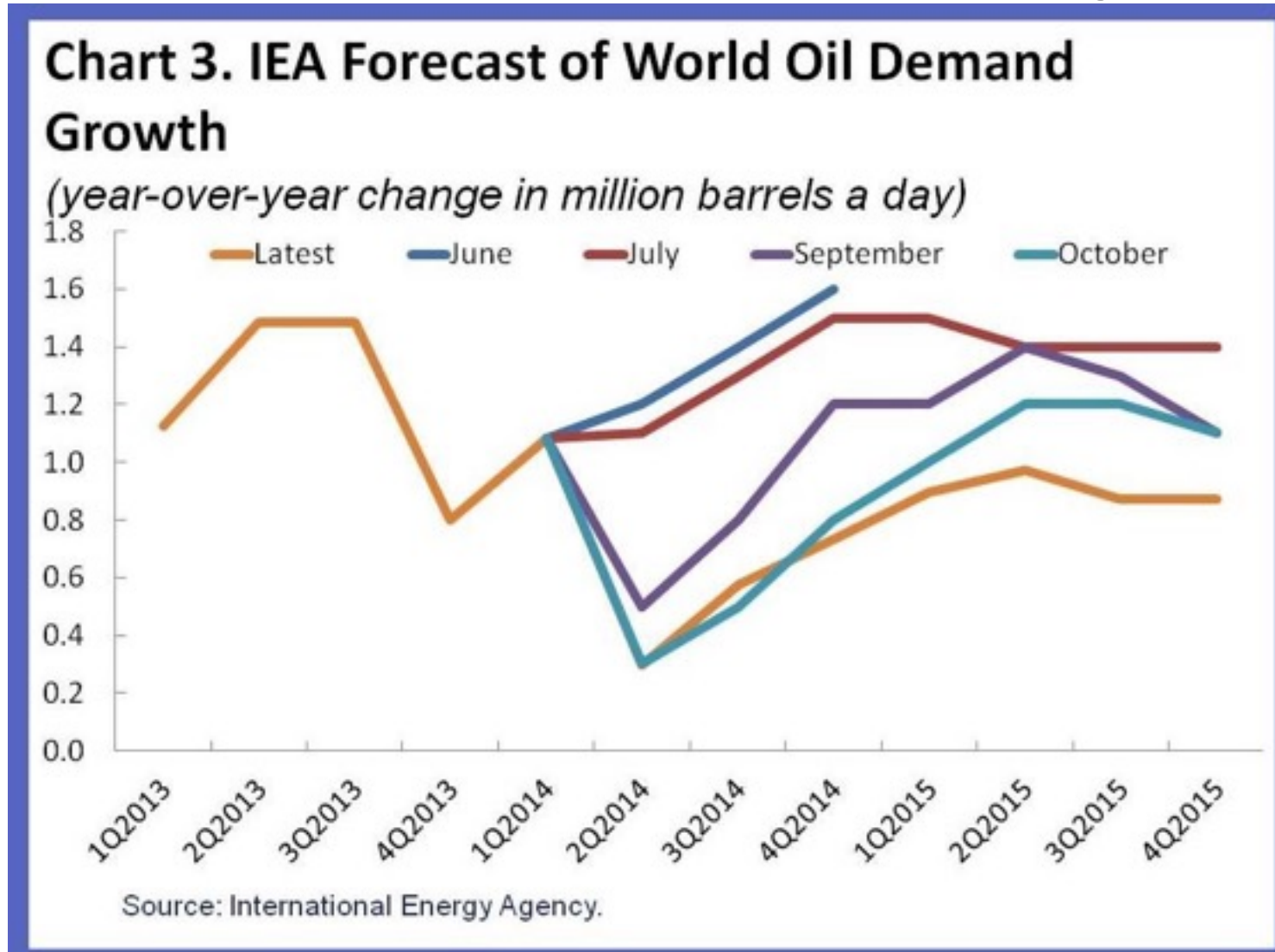
And people who aren't working drive less



Oil is being produced much faster than it is being consumed in the United States



IEA forecasts of global near-term oil demand have fallen dramatically



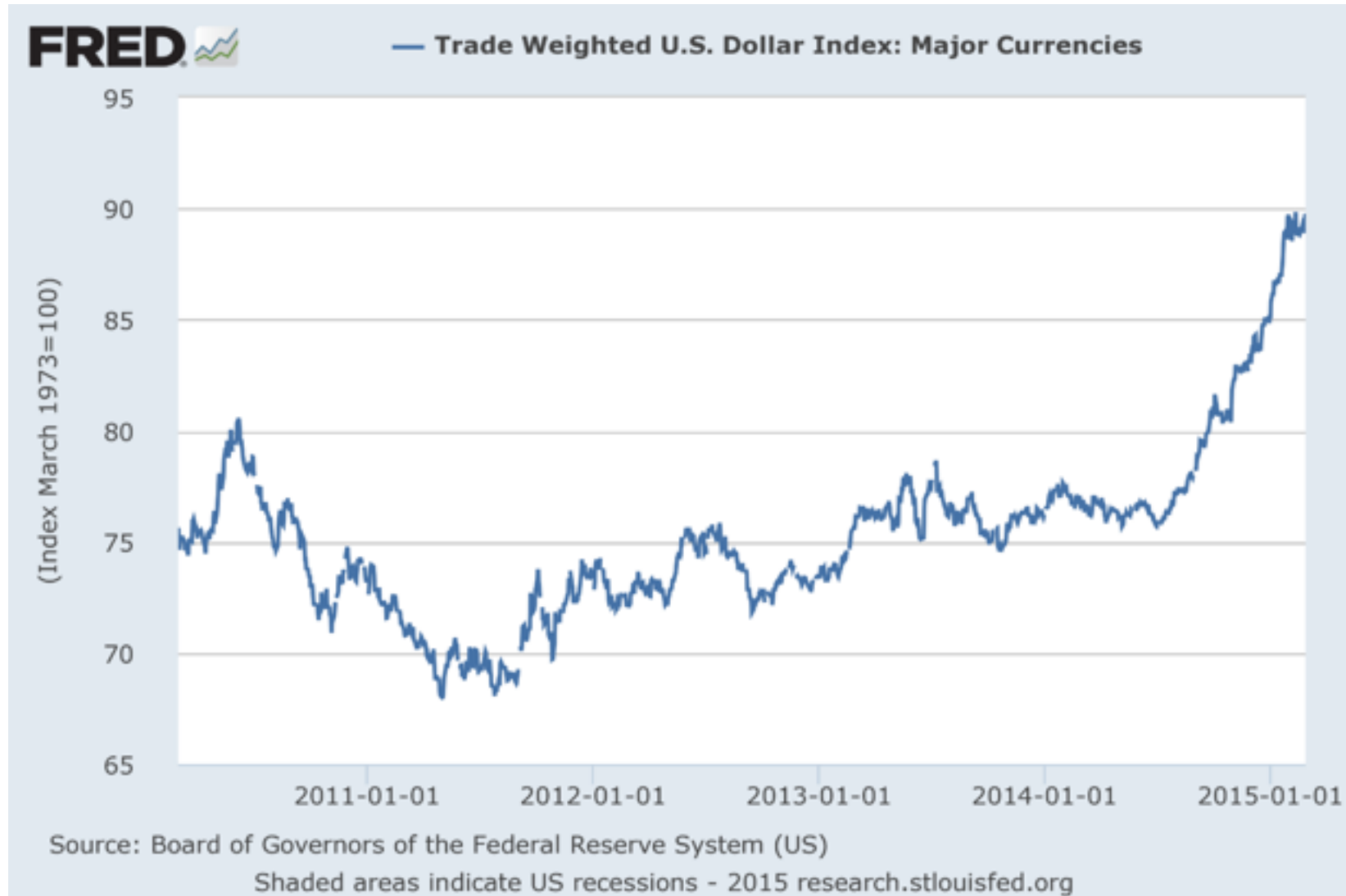
Copper and other commodity prices have been falling along with oil



Interest rates have also fallen on concerns of economic weakness of Europe and Japan



The dollar has strengthened against other currencies on the same news



How much of oil price decline can be explained by factors other than oil supply?

- Regression of weekly change in crude oil price on weekly change in copper price, bond yield, and value of dollar (estimated April 2007 to June 2014):

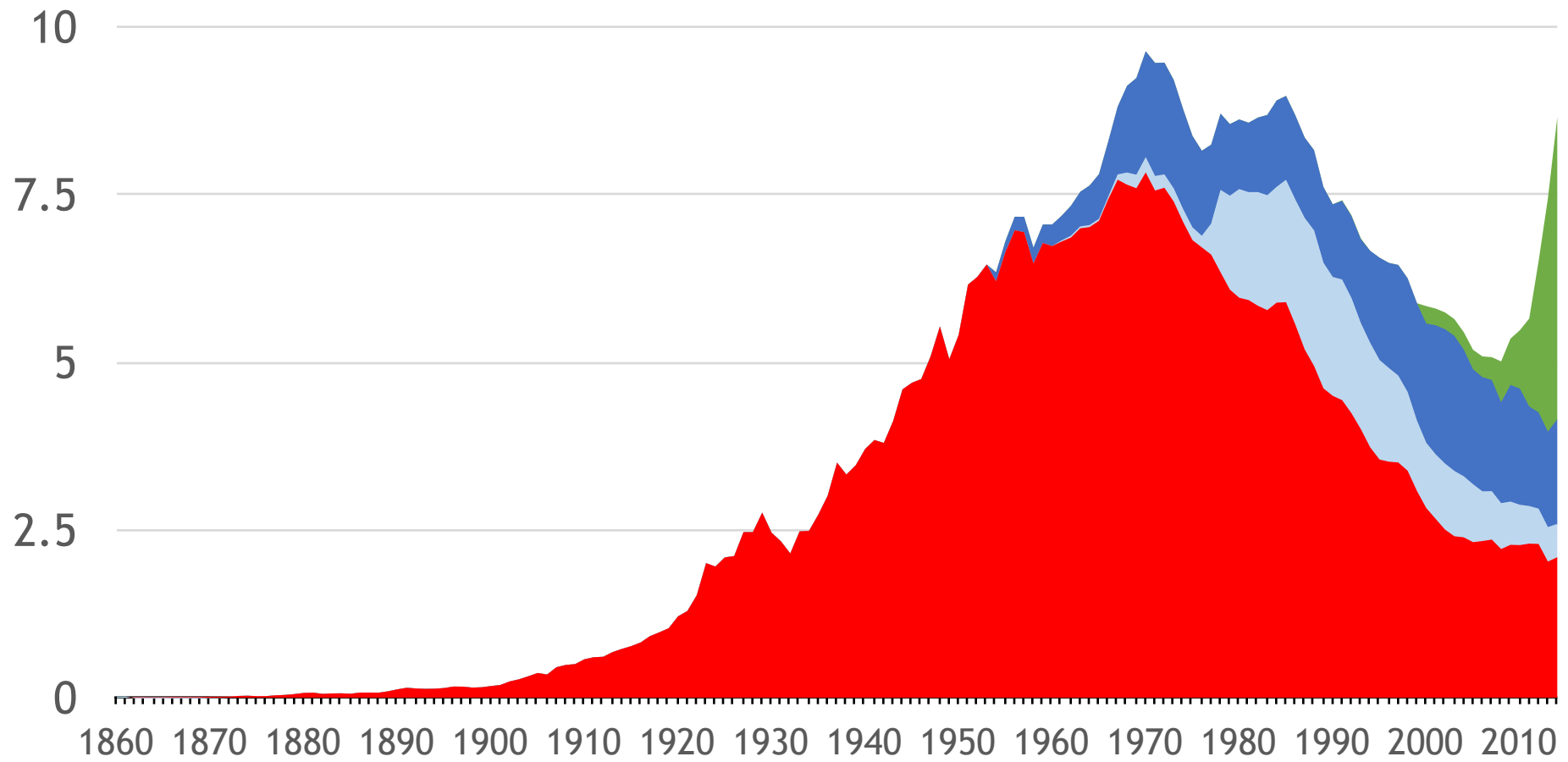
$$\Delta p_{oil,t} = 0.363 \Delta p_{copper,t} - 1.253 \Delta p_{dollar,t} + 9.442 \Delta r_{10y,t} + \hat{e}_t \quad R^2 = 0.33$$

(3.40) (4.44) (2.84)

- Would predict a decline in price of Brent from \$105 in June to \$75 today on basis of change since June in copper price, value of dollar, and interest rate.
- Suggests weakening global demand also contributed to falling oil prices.

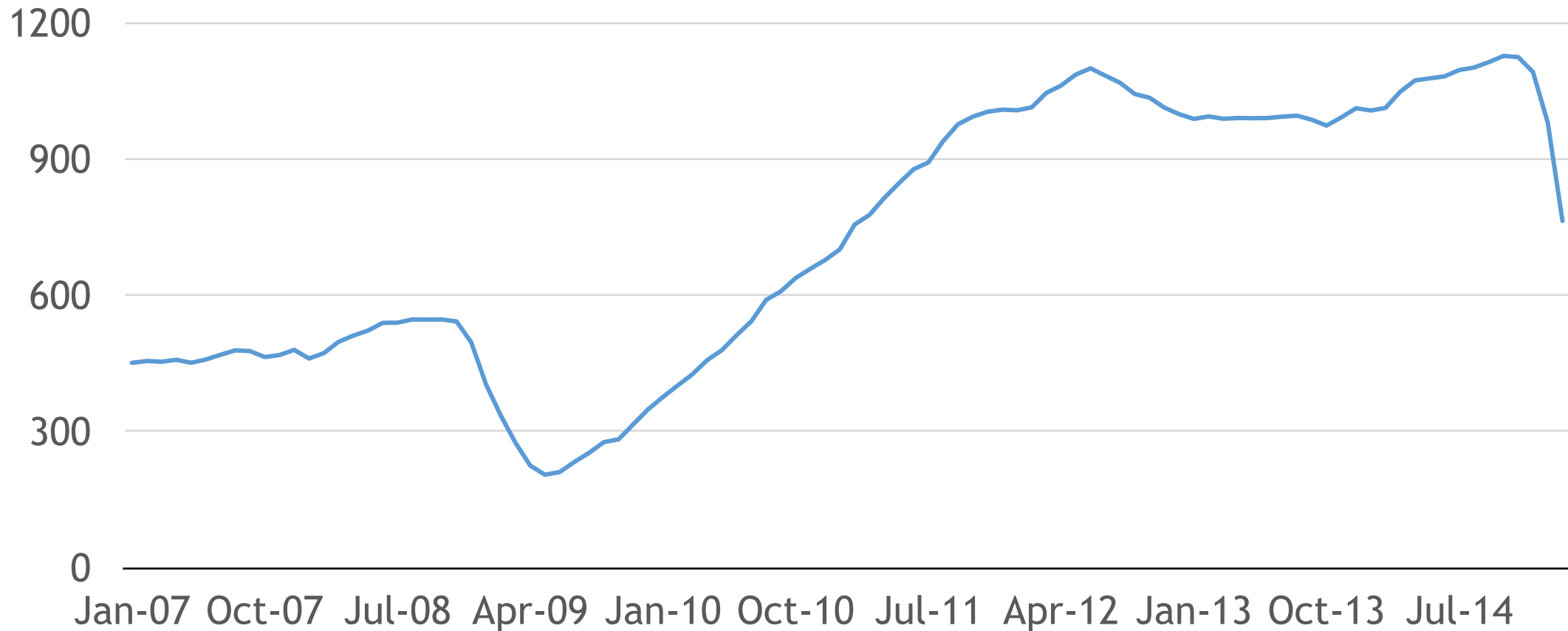
Much of the new production isn't profitable at current prices

U.S. oil production by source



■ lower 48 ■ Alaska ■ offshore
■ tight oil

Number of drilling rigs in U.S. tight oil has already fallen significantly



Conclusion

- Much of the conservation response will not be sustained if prices remain low.
- Much of the new supply will not be sustained if prices remain low.
- Concerns about a weak global economy are short-run.

World real price of oil (2014 \$/barrel, 1861-2014)

