"Abstract Energy Gain and the EROI Accordion"

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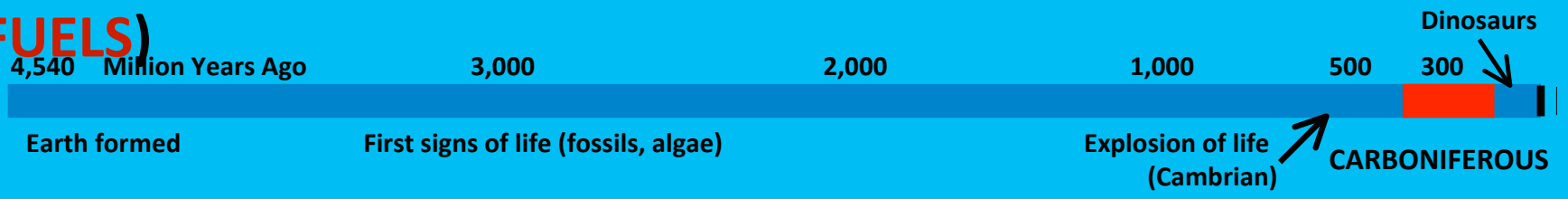
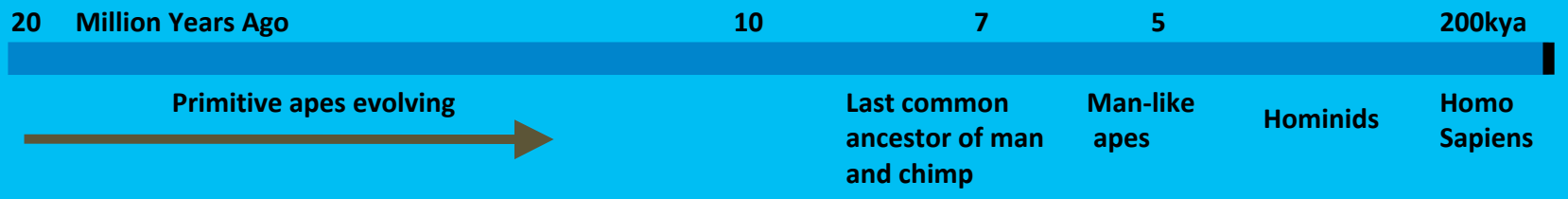
Nathan John Hagens
The University of Vermont
www.theoildrum.com

HUMANS AND ENERGY - A TIMELINE

FORMATION OF MODERN ENERGY SUPPLY (FOSSIL FUELS)



FORMATION OF MODERN ENERGY DEMAND (HUMAN BRAIN)

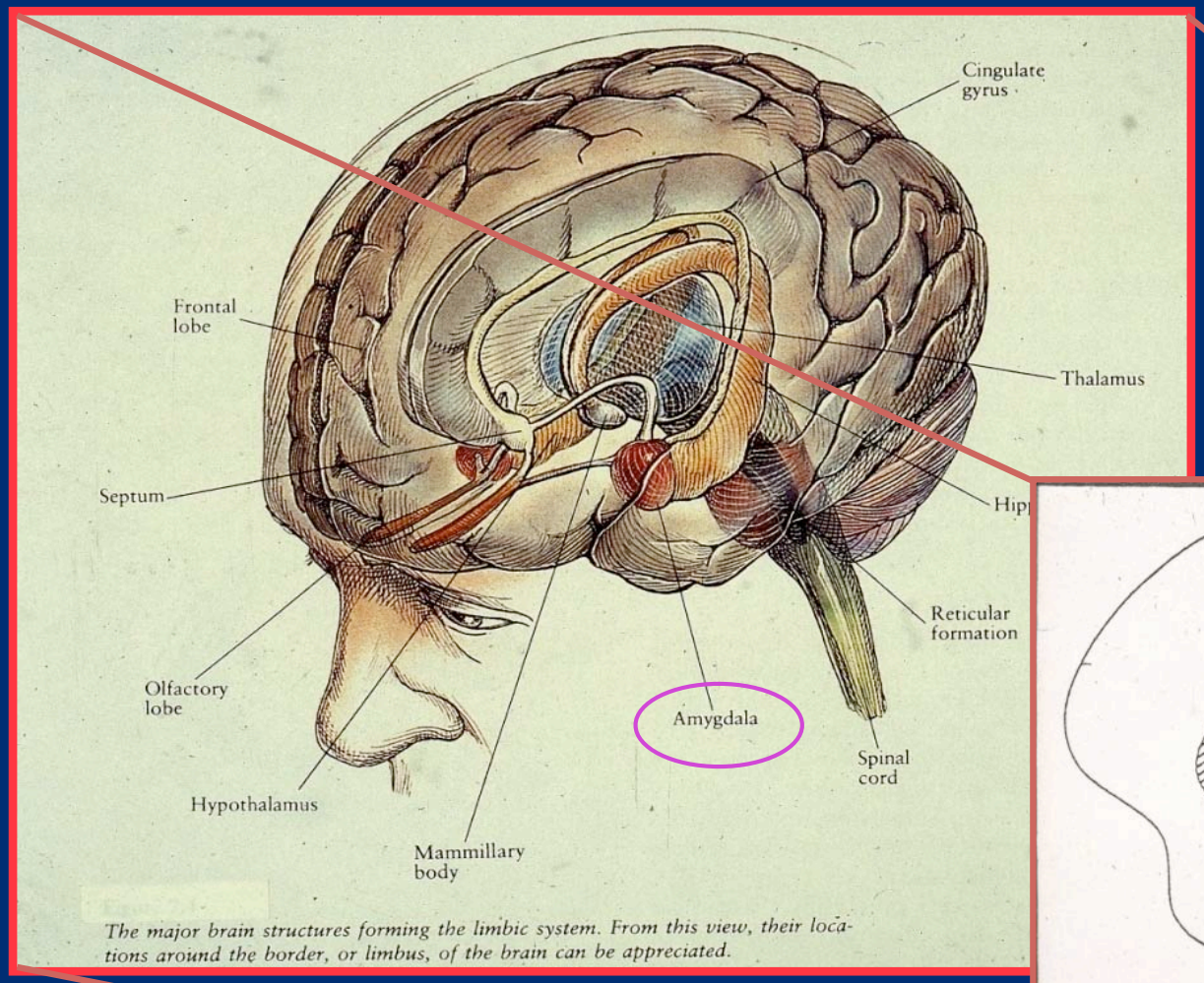


INTERSECTION OF ENERGY SUPPLY AND DEMAND

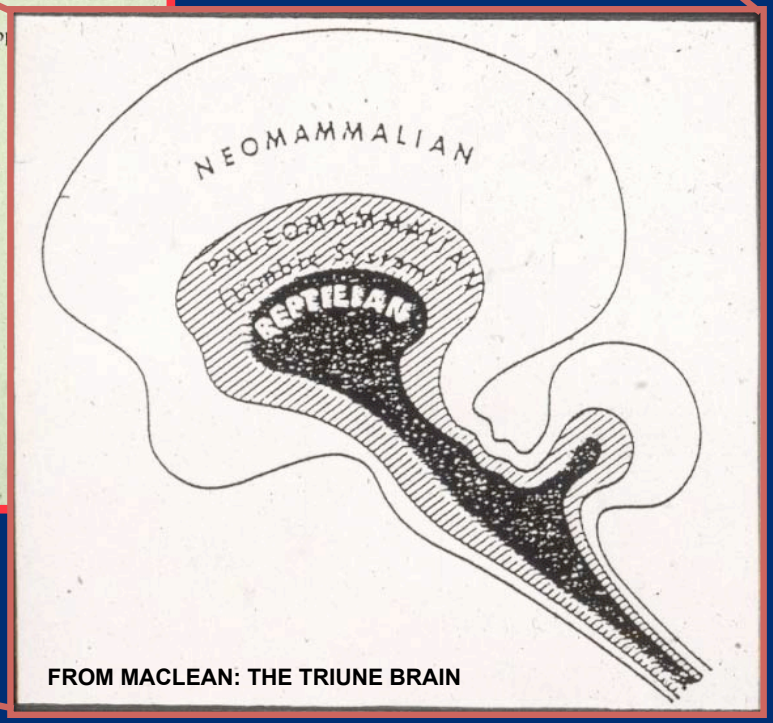
Graphic adapted from Dr. William Stanton

BEHAVIOR IS BEST UNDERSTOOD THROUGH THE LENS OF EVOLUTION

HOMO SAPIENS EVOLVED AMIDST SCARCITY



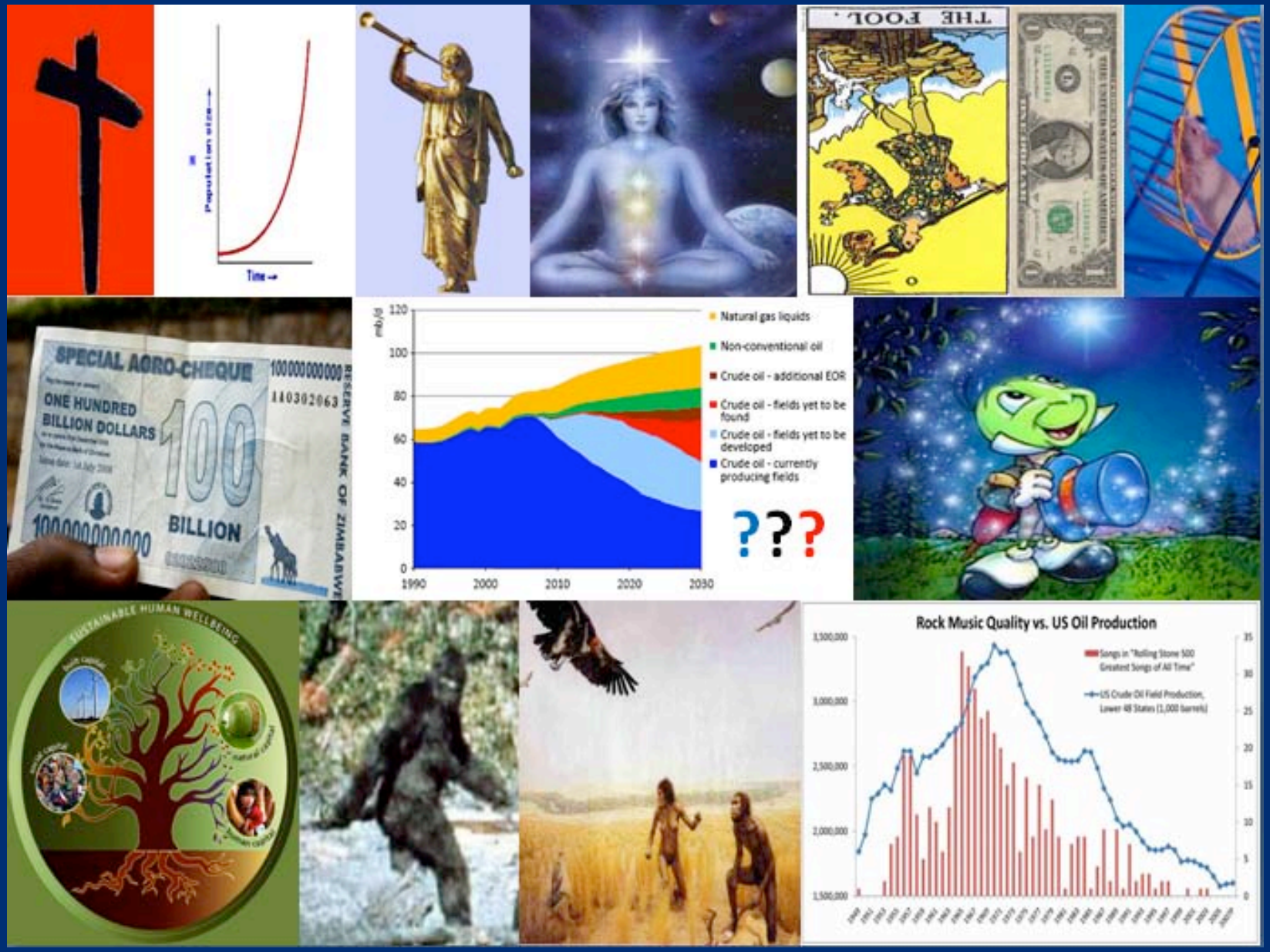
The major brain structures forming the limbic system. From this view, their locations around the border, or limbus, of the brain can be appreciated.



FROM MACLEAN: THE TRIUNE BRAIN

Graphic Credit: Dr. Peter Whybrow – UCLA – Author of "*American Mania*"

Belief, Religion, Economics, etc.




OIL

334,600,000
BTU per year

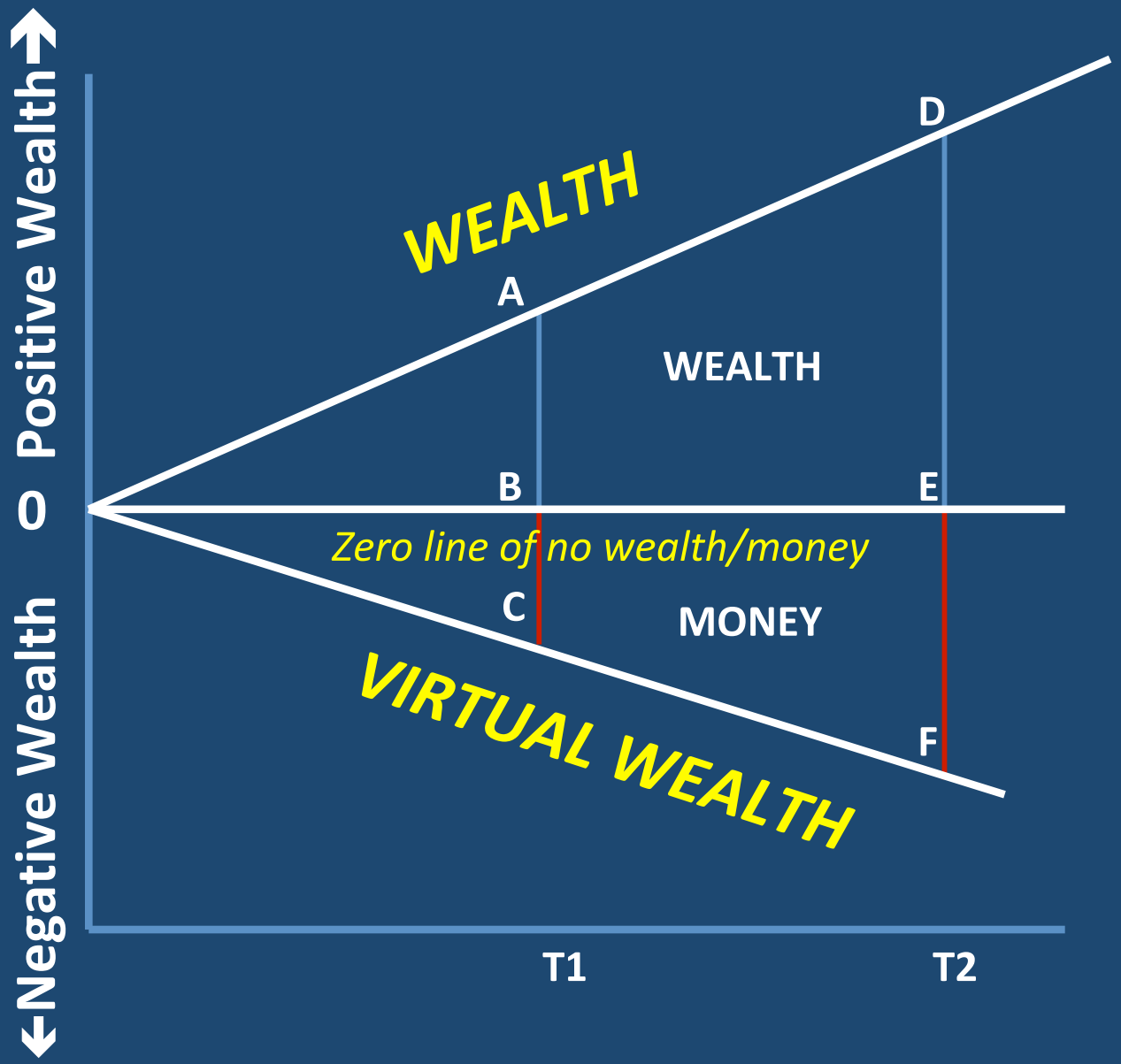
84,317,000
Nutritional calories
per year

231,000
Calories per day

ENERGY DIET
USA, 2006

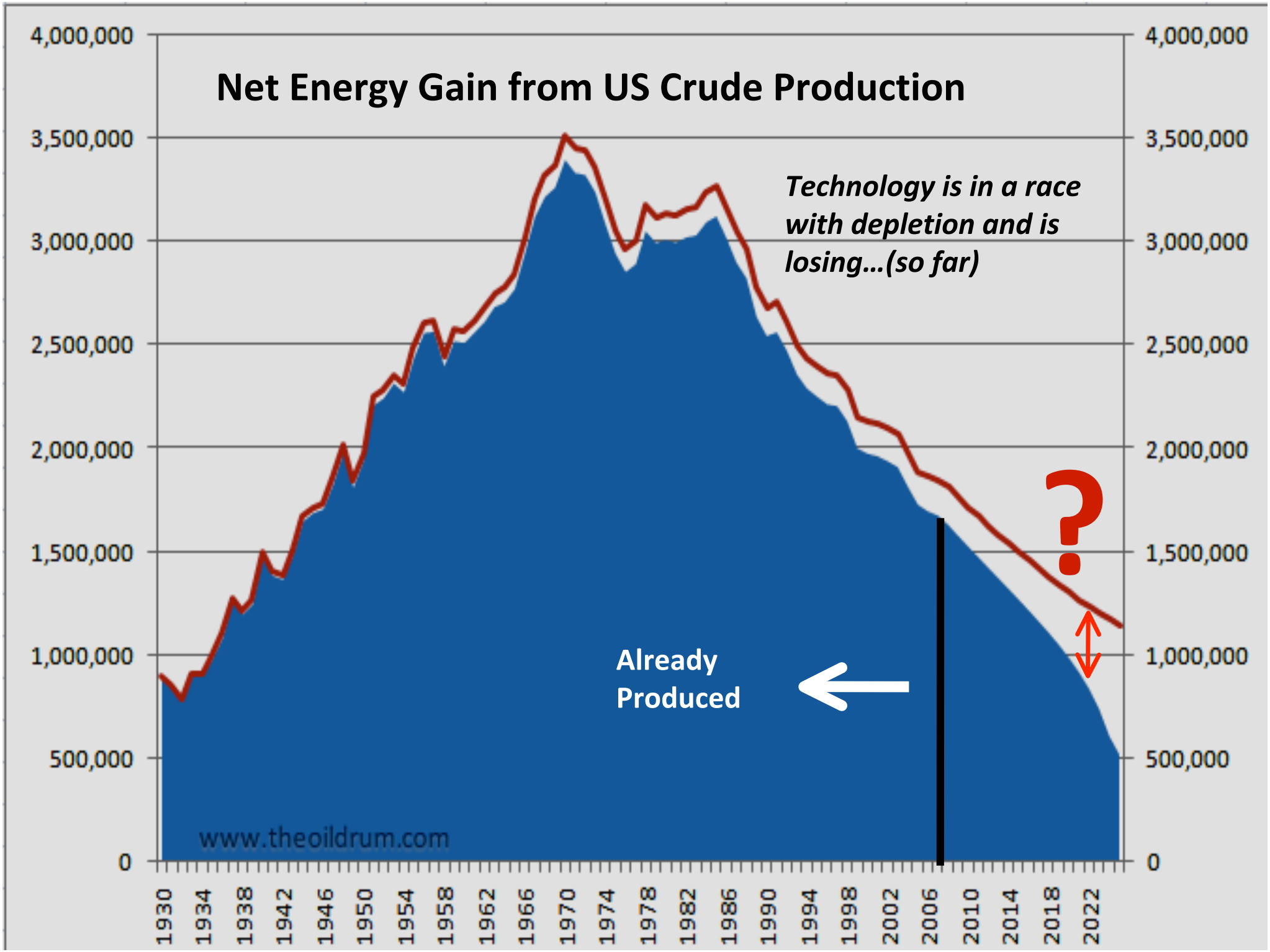
3,000 calories
endosomatically

Source EIA 2006

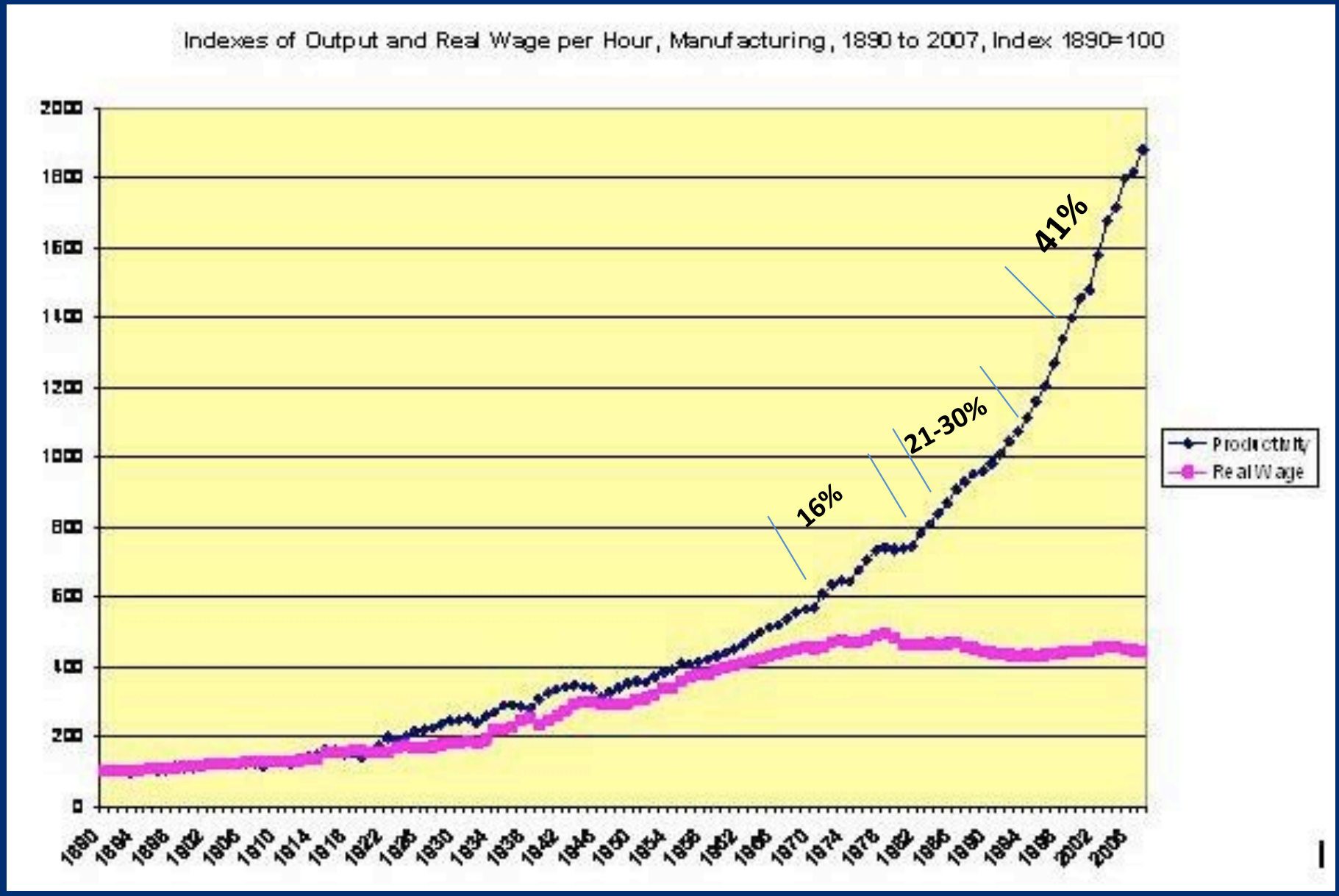


Graphic adapted from 'Wealth, Virtual Wealth and Debt, 1926 Frederick Soddy

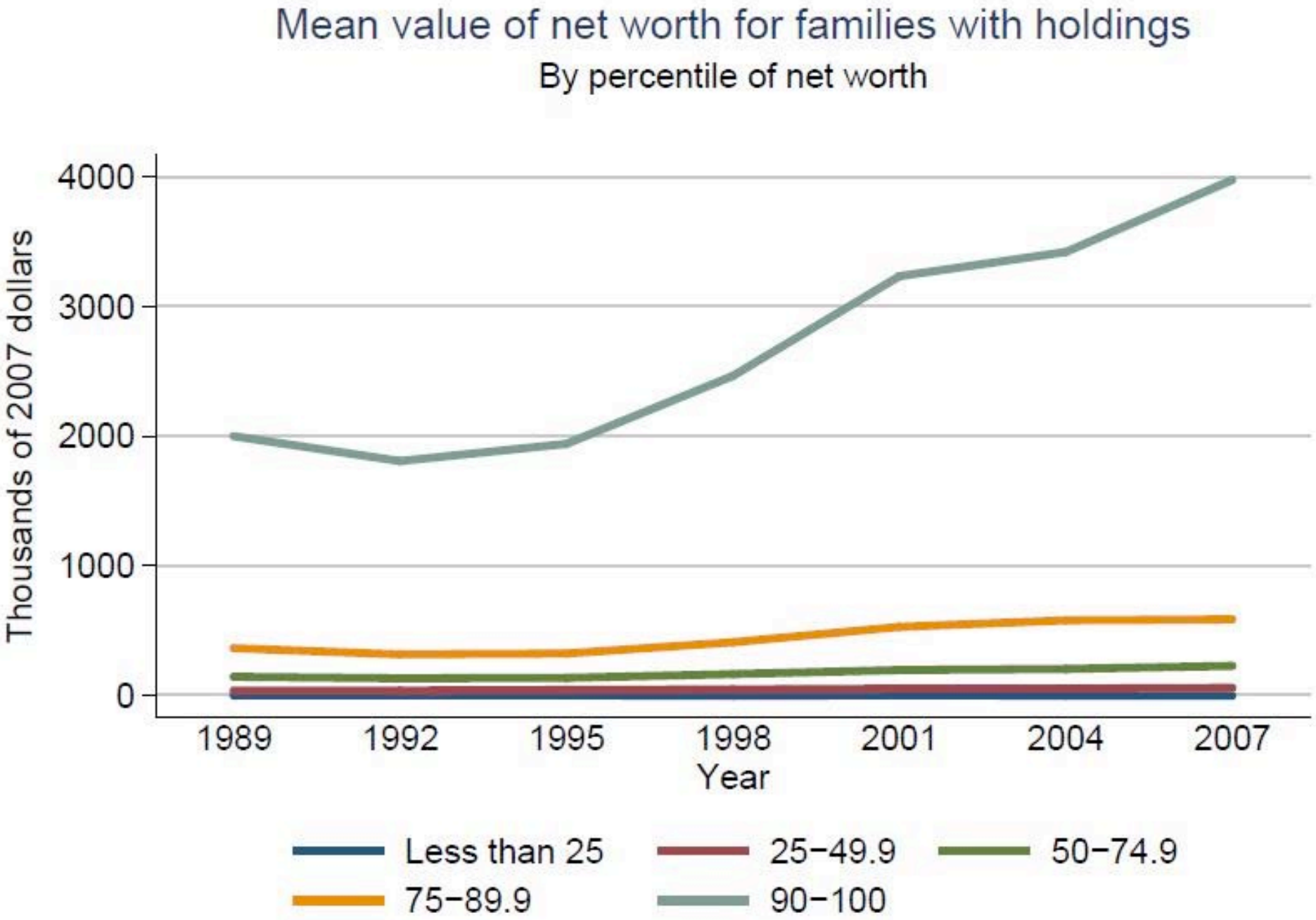
What Happened?


Net Energy Gain from US Crude Production
Technology is in a race with depletion and is losing…(so far)
?
Already Produced
www.theoildrum.com
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
1930
1934
1938
1942
1946
1950
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
2010
2014
2018
2022

US Peak Oil 1970, End of $ into Gold 1971, All time peak in real wages 1973

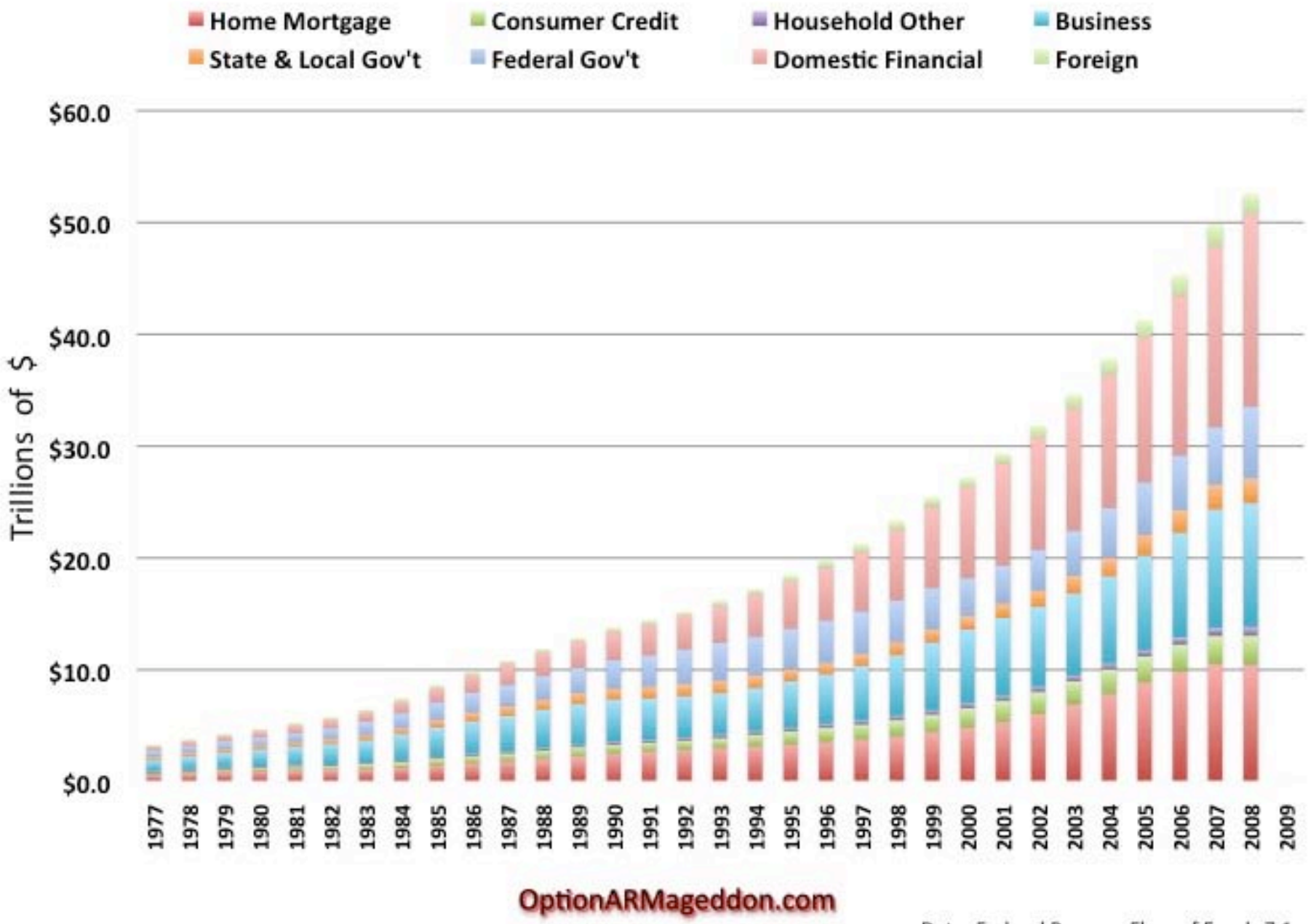


Source Richard Wolfe – UMass
David Brooks, NYTimes 4/2009

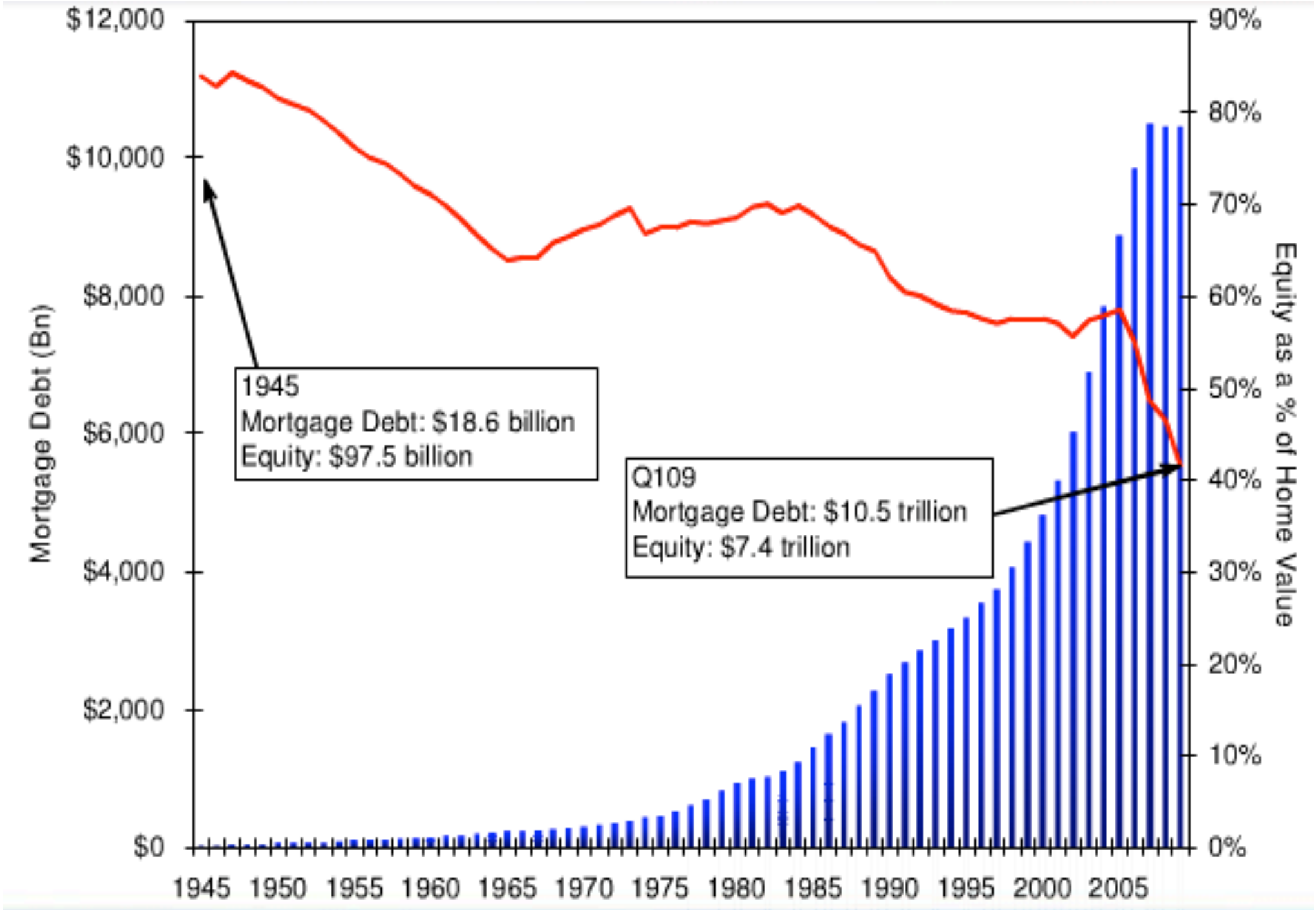


Source: Federal Reserve Standards Board

U.S. Debt Outstanding by Sector



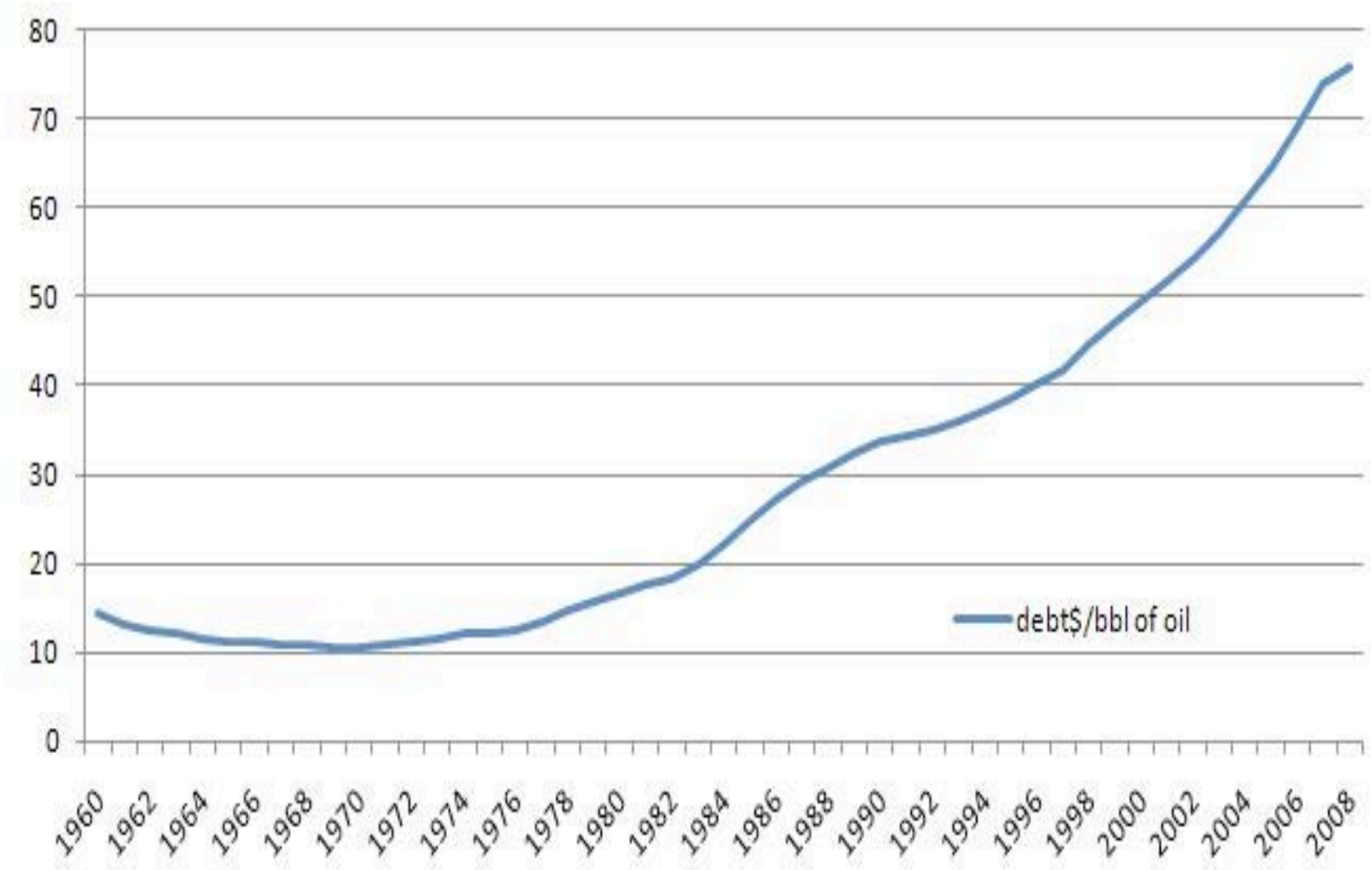
Data: Federal Reserve Flow of Funds Z.1



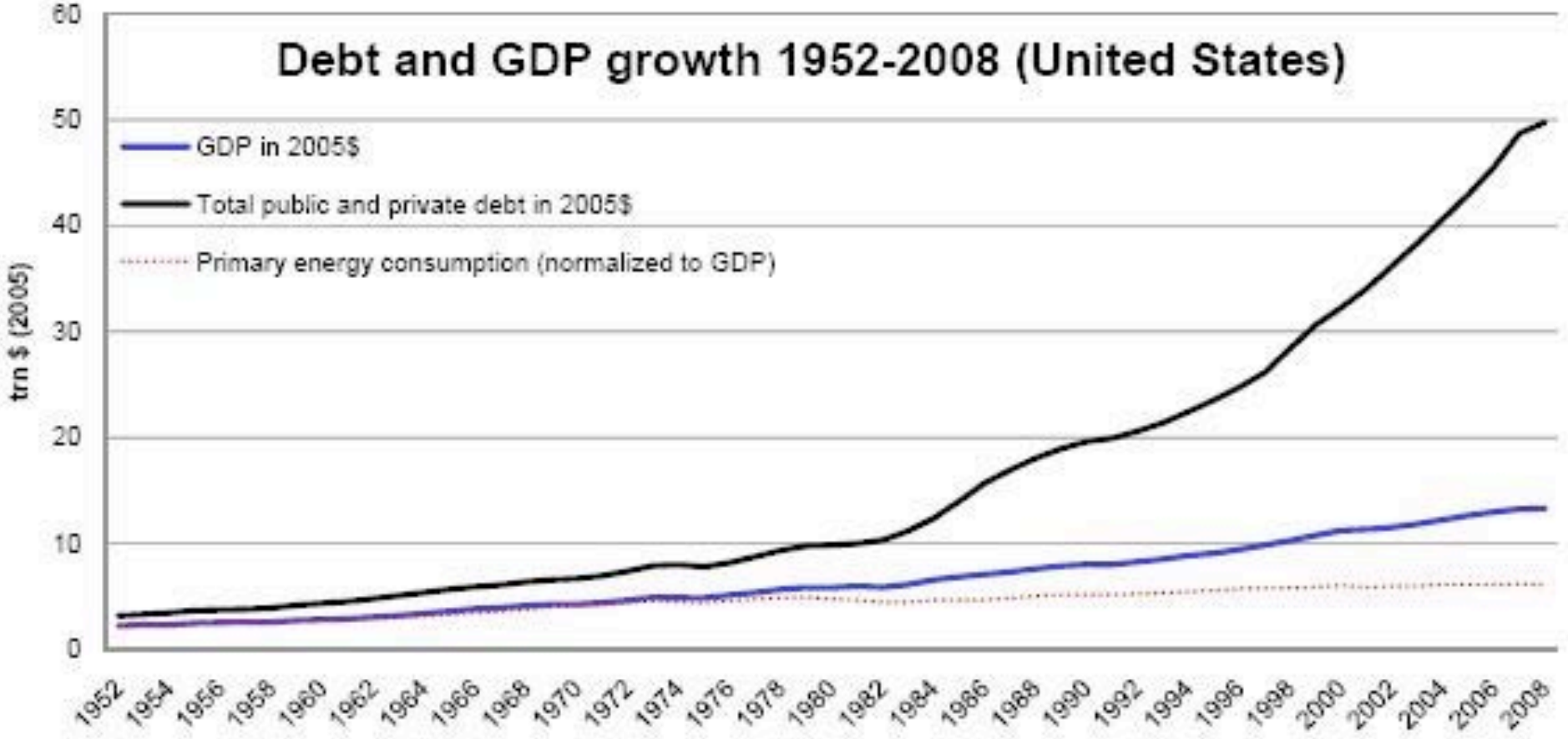
SOURCE: Federal Reserve Flow of Funds Data

T2 Partners

HOW MUCH DEBT WAS ADDED ***RELATIVE*** TO ENERGY CONSUMPTION ??



Over the past 50+ years, two components supported growth: energy and money supply (=debt) increases



- Before 1973: Energy was cheap and growth directly possible from increased use, during this period, energy consumption grew along with GDP
- After 1973: Energy became more expensive, and easy growth was only possible through vastly increased supply of funds (through debt)

IIER 2009

Today, return expectations put unrealistic pressure on global growth requirements

Global Situation (2009)

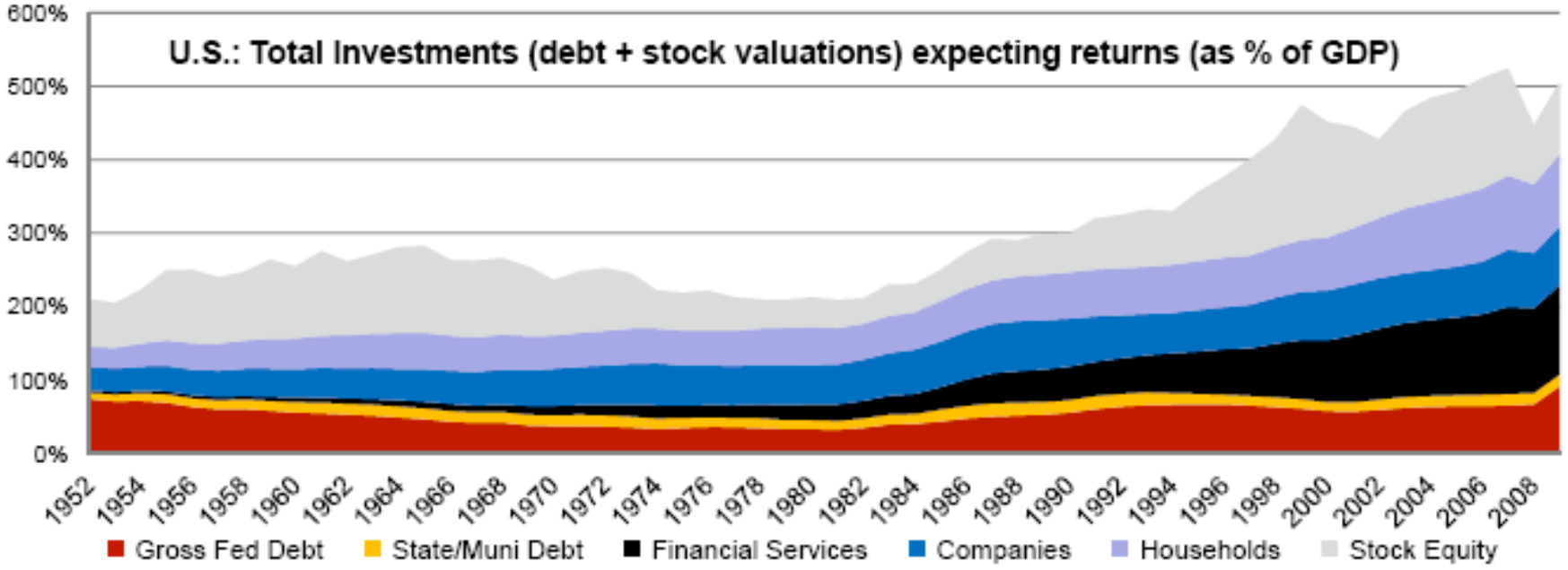
- Total debt+stock investments are estimated at approximately 345% of global GDP
- Real return expectations of 2%** would require 6.9% annual (real) GDP growth

Germany (2009)

- Total debt+stock markets are at approximately 560% of GDP
- A 1%* return expectation requires 5.6% (real) GDP growth per annum

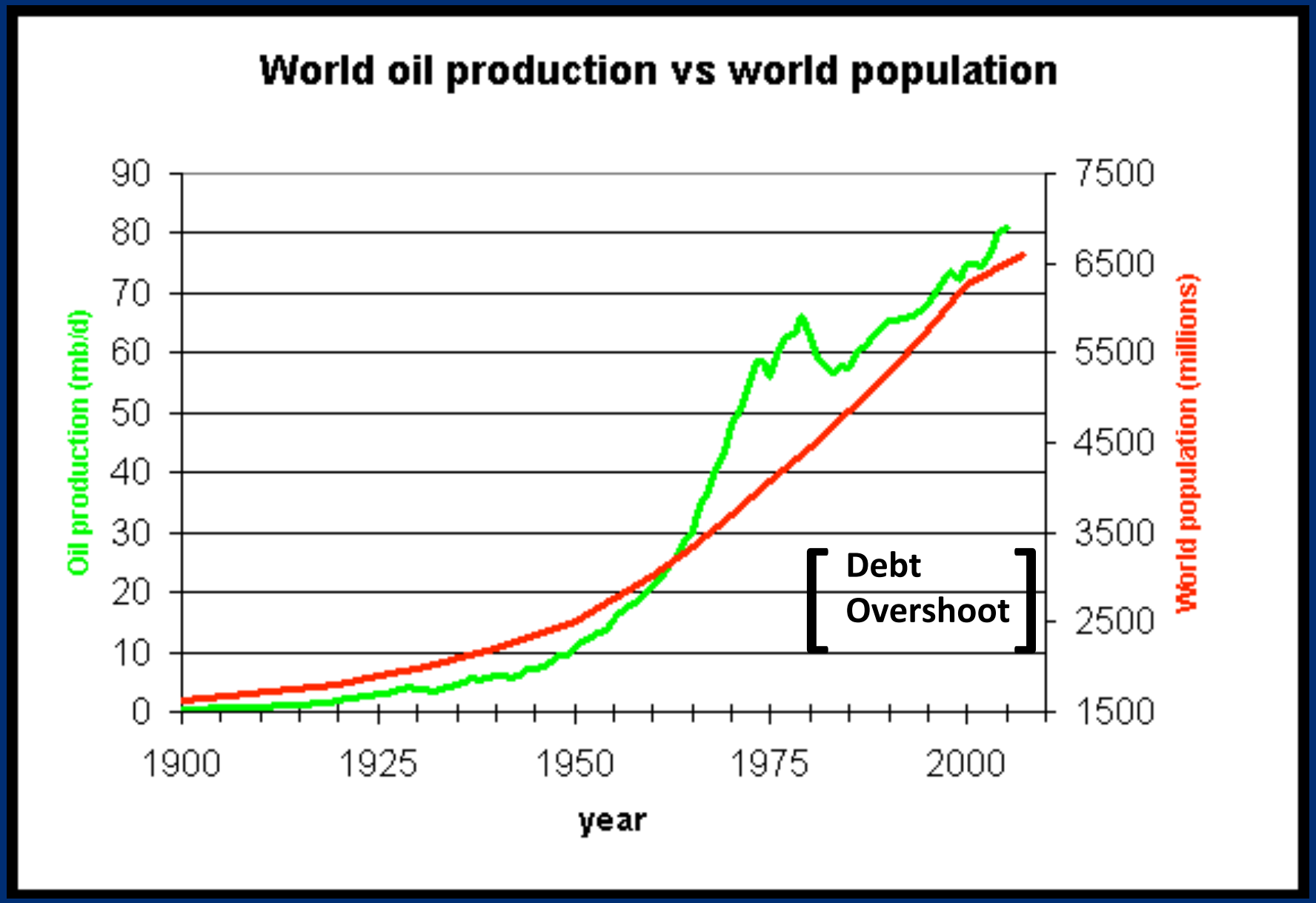
United States (1952-2009)

- Debt* has grown from 145% to 390%, while stock market valuations fluctuated between 40% and 150%, current total is 505% of GDP
- A 1% return expectation requires 5% (real) GDP growth per annum

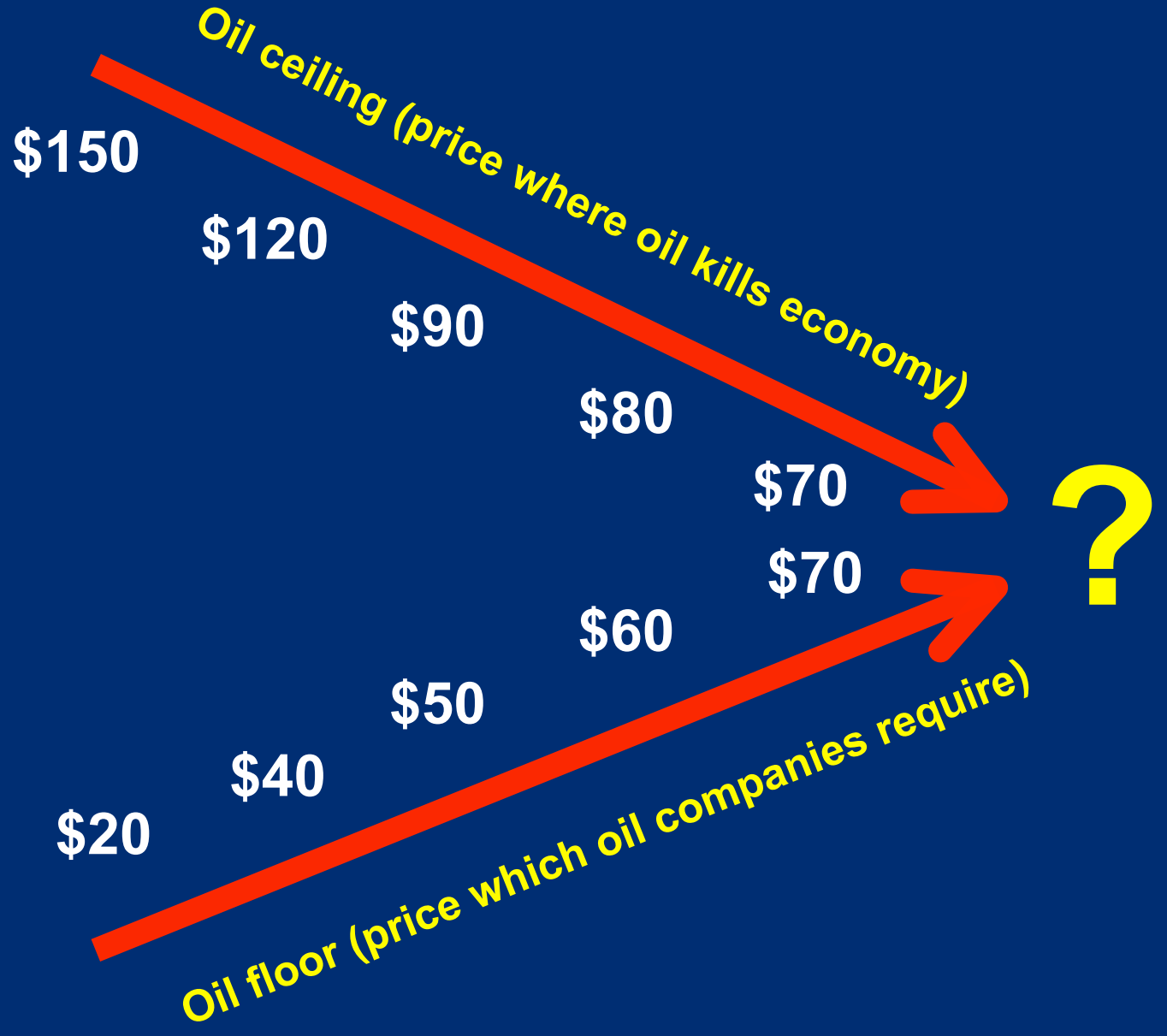


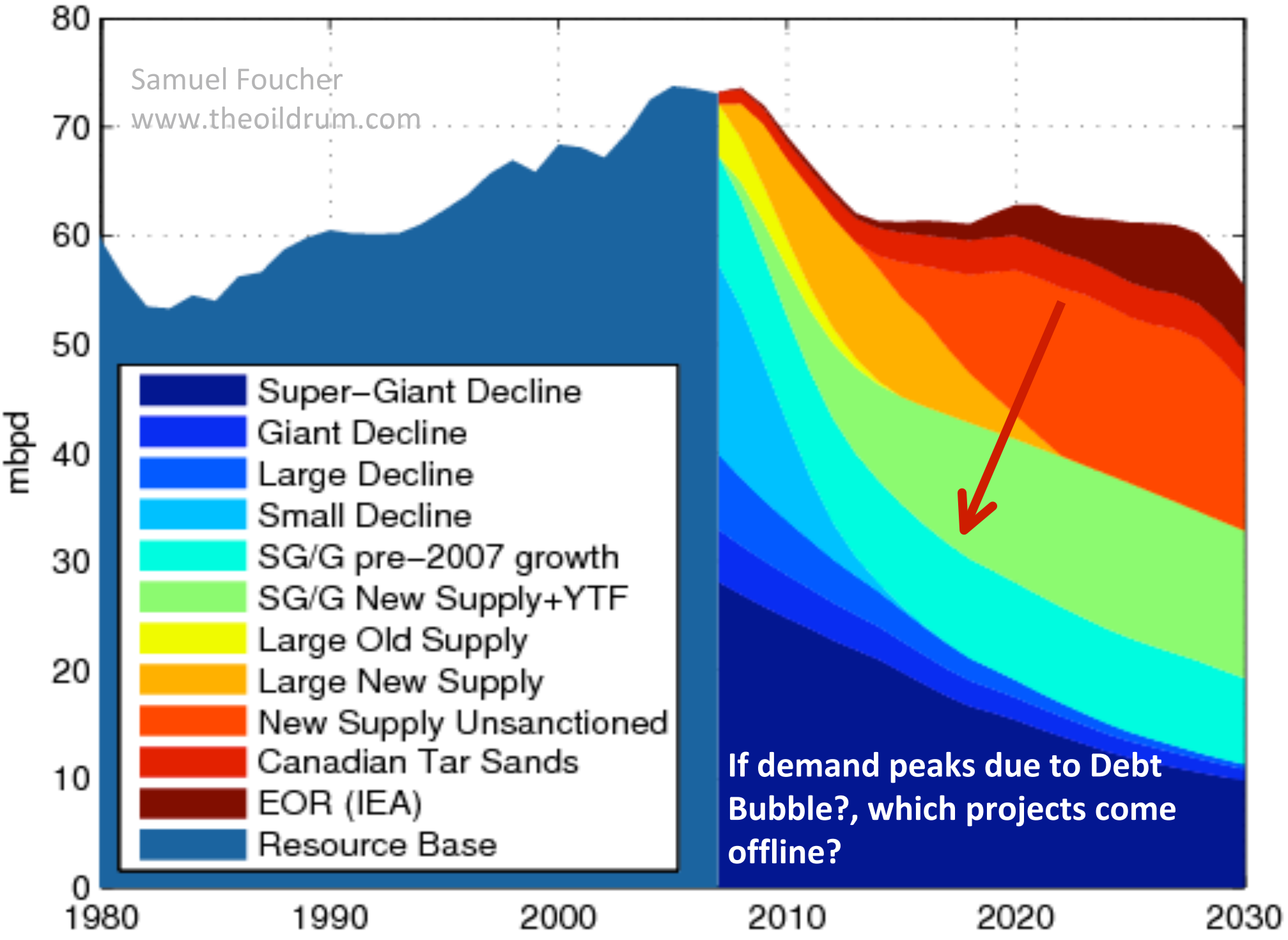
*Source: Multiple, United States: U.S. Federal Reserve Flow of Funds, does NOT include further hidden debt (future social security obligations, private debt), and does not net out federal debt held by other government agencies (mostly social security institutions), e.g. shows gross federal debt, as intragovernmental debt represents real liabilities

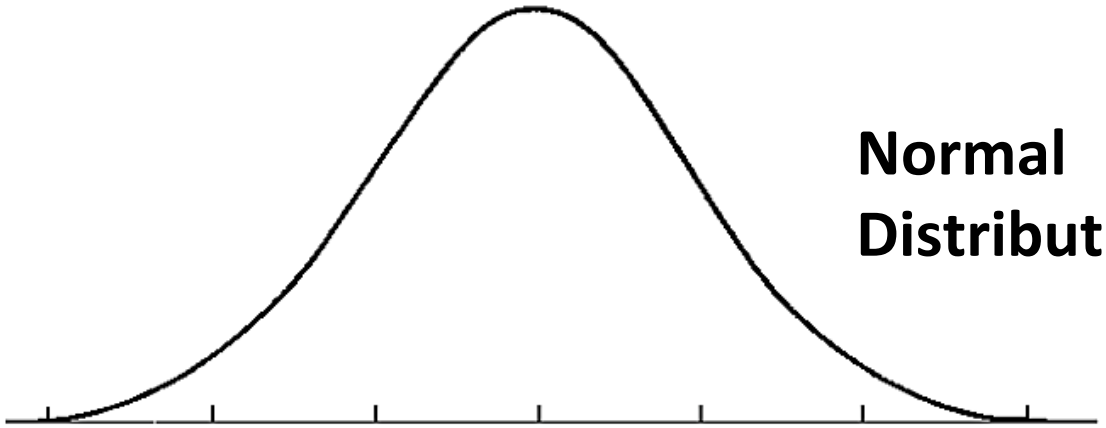
** International return expectations are assumed to be higher due to market expectations on a global average when compared with mature economies like the United States or Germany

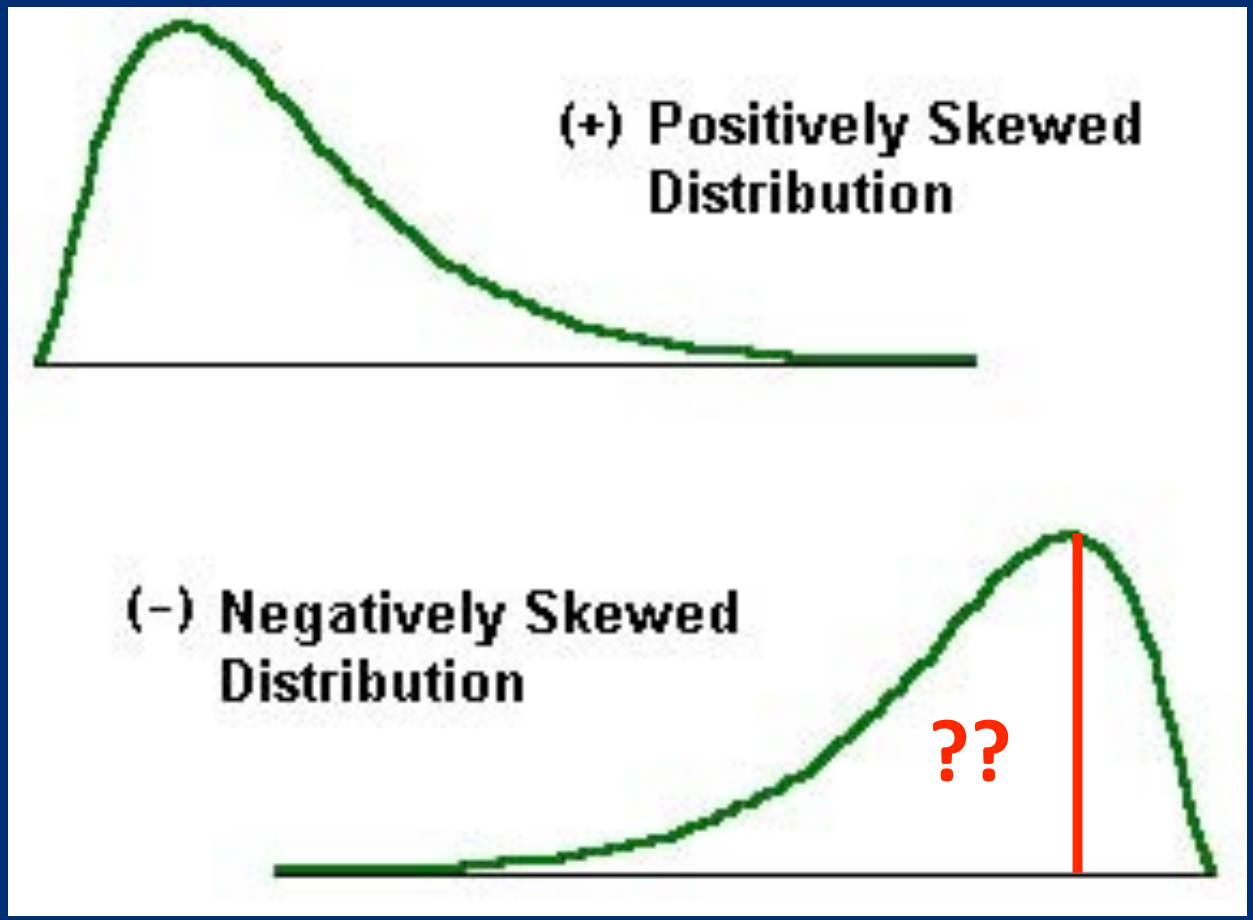

World oil production vs world population
Oil production (mb/d)
World population (millions)
90
80
70
60
50
40
30
20
10
0
7500
6500
5500
4500
3500
2500
1500
1900
1925
1950
1975
2000
year
Debt
Overshoot

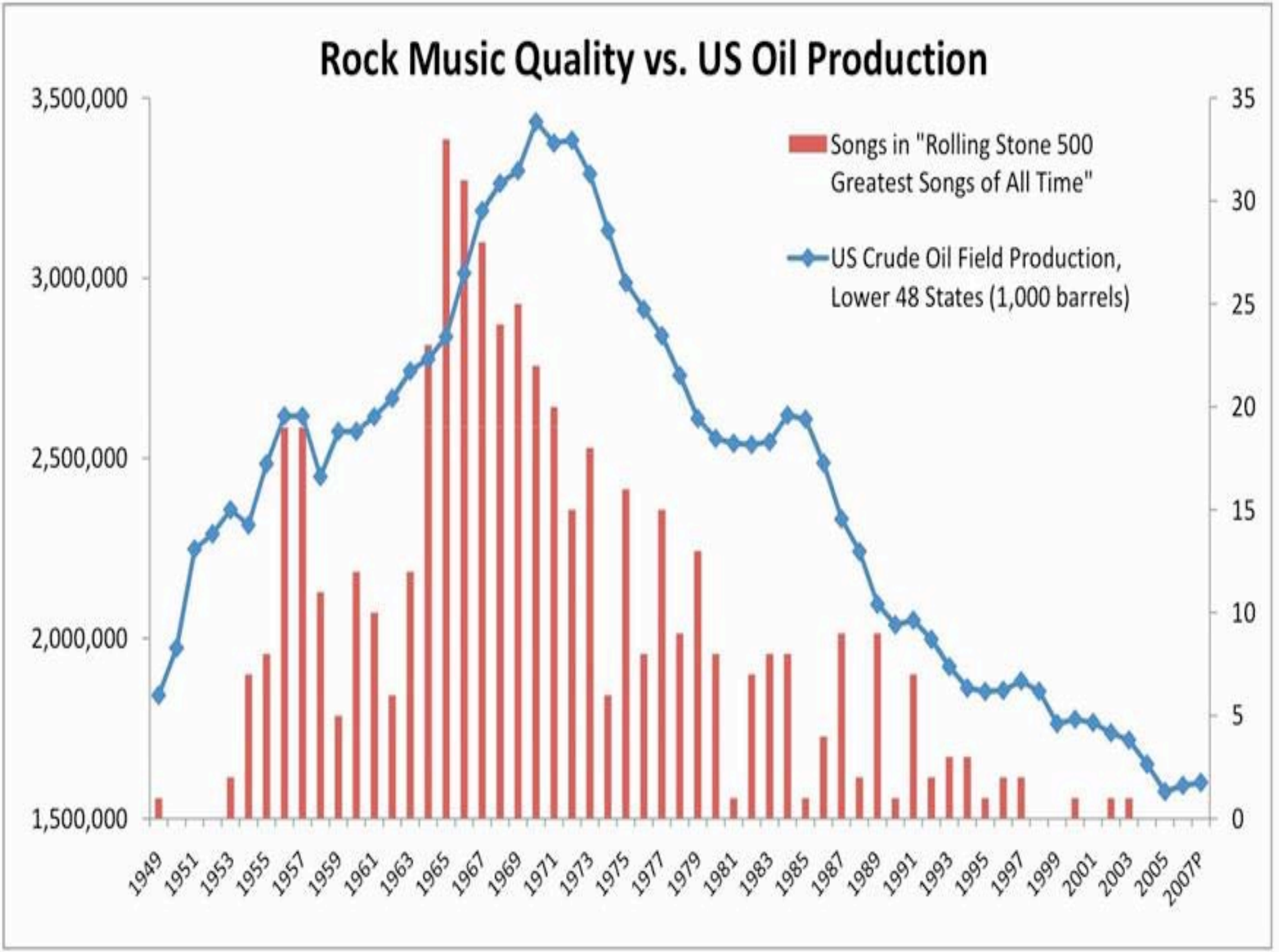
The Biophysical Gauntlet




Samuel Foucher
www.theoildrum.com
mbpd
80
70
60
50
40
30
20
10
0
1980
1990
2000
2010
2020
2030
Super–Giant Decline
Giant Decline
Large Decline
Small Decline
SG/G pre–2007 growth
SG/G New Supply+YTF
Large Old Supply
Large New Supply
New Supply Unsanctioned
Canadian Tar Sands
EOR (IEA)
Resource Base
If demand peaks due to Debt Bubble?, which projects come offline?


Normal
Distribution


(+) Positively Skewed
Distribution
(-) Negatively Skewed
Distribution
??


Rock Music Quality vs. US Oil Production
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
35
30
25
20
15
10
5
0
Songs in "Rolling Stone 500 Greatest Songs of All Time"
US Crude Oil Field Production, Lower 48 States (1,000 barrels)
1949
1951
1953
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007P

CONCLUSIONS

- Debt “Overshoot” caused us to borrow from future affordability of energy and natural resources
- We are likely in the late stages of majority believing that fiat currencies will hold their value indefinitely
- We are not approaching energy breakeven– but our debt burden implies a likely reset of both how we measure our wealth and how we use it.

Questions Requiring Further Research

- How much will future energy production cost in natural resource terms?

- What portion of historical and new investment generates viable future returns (vs. fast heat loss or dead end infrastructure)?

- How far is global debt disconnect from affordable future flows? (i.e. 'Reset' or 'adjustment'?)

- How do you synthesize human demand drivers with supply constraints after claims reshuffle??