What happens next?
Boom or bust?

Photo credit: Richard Drew, AP

"We ain't seen nothin' yet" is quoted from Barron's, Feb. 1988

Era of low-inflation economic growth and explosion of new technologies

Short answer: a continued global financial and economic boom subject to episodic, healthy market price corrections is much more likely to occur than a fearsome bust like the near-collapse of U.S. financial markets in 2008 and subsequent Great Recession from which world financial markets and many national economies are just beginning to fully recover. Herein we present key reasons why this bullish scenario should transpire as events unfold.

Quant in financial and commodity markets for many years

Returned to my earlier roots in theoretical physics for Lattice back in 2001

From the early 1980s to mid-1990s, Larsen developed interrelated conceptual models that qualitatively forecast future macroeconomic environments, including inflation and 20^{+}-year bond rates, as well as long-term, secular price trends in stocks versus prices of commodities like Gold and other types of precious metals

Photo credit: Lloyd DeGrane (Chicago)

Long-range conceptual models qualitatively forecast future

Final outcomes easier to forecast than rates of change for key parameters

There are a number of powerful long-term macroeconomic, socioeconomic, and technological forces that unobtrusively shape everyday markets and guide unfolding events. These forces operate subtly behind random day-to-day background market noise and are only dimly glimpsed over shorter-term time horizons. However, over decades they will create persistent long-term secular trends in markets and prices. Once these key underlying driving force-parameters have been identified, and dynamics of processes impacting their rates of change are understood, conceptual models based on operation of these variable and dynamic long range forces can be used to broadly forecast upcoming macroeconomic and market environments decades into the future with reasonable *qualitative* accuracy.

Long-range conceptual models qualitatively forecast future

Qualitative model correctly predicted certain macroeconomic parameters

"The model predicts that as long as government policies insure that inflation rates do not exceed 3 - 5%, there will be a continuing shift from tangible into financial assets in household portfolios. This shift will in turn create a secular decline in interest rates and a secular uptrend in the stock market. Oscillations around these trends will be determined by 'normal' business cycles and fine-tuning of monetary and fiscal policies. The presence or absence of large federal budget deficits cannot prevent this evolution of events as long as inflation is in check. Deficits are not inflationary as long as they are not monetized."

Larsen macroeconomic theory paper

March 10, 1985

Image credit: Saul Gravy/Getty Images

Forecasts of Larsen qualitative models reported in Barron's

Scanned copies of 1986, 1988, and 1999 articles downloadable as pdf files

BARRON'S

Forecasts of Larsen models were reported, details of underlying concepts were elaborated, and supporting data for models, were all discussed in three long articles by *Barron's* columnist Jonathan Laing that were published in 1986, 1988, and 1999. Keynote points mentioned in Laing's news stories will be covered herein. URLs to downloadable pdf copies of Laing's entire articles are given in references provided on next slide in this presentation.

Laura 13

Original pdf source documents available for free download

Brief outline of what may happen in near-future provided on Slides 67 - 69

Larsen March 10, 1985 macroeconomic theory preprint (5-pages) April 14, 2012 (copy of paper inside 19-page pdf of MS-Word document)

https://www.slideshare.net/lewisglarsen/lattice-energy-llc-macroeconomics-technology-and-long-sweep-of-historyapril-14-2012

Scanned copies of three *Barron's* articles in 1986, 1988, and 1999 April 27, 2013 (12-page pdf document in MS-Word format)

https://www.slideshare.net/lewisglarsen/lewis-larsenbarrons-magazine-articles-by-jon-laingpublished-2013-1999-1988-1986-april-27-2013

Larsen memo re anomalies in DJIA/Gold and S&P/Gold price ratios August 10, 2011 (pdf copy of 13-page MS-Word document)

https://www.slideshare.net/lewisglarsen/lattice-energy-llclarsen-memo-re-stock-indexes-vs-gold-price-ratiosaugust-10-2011/1

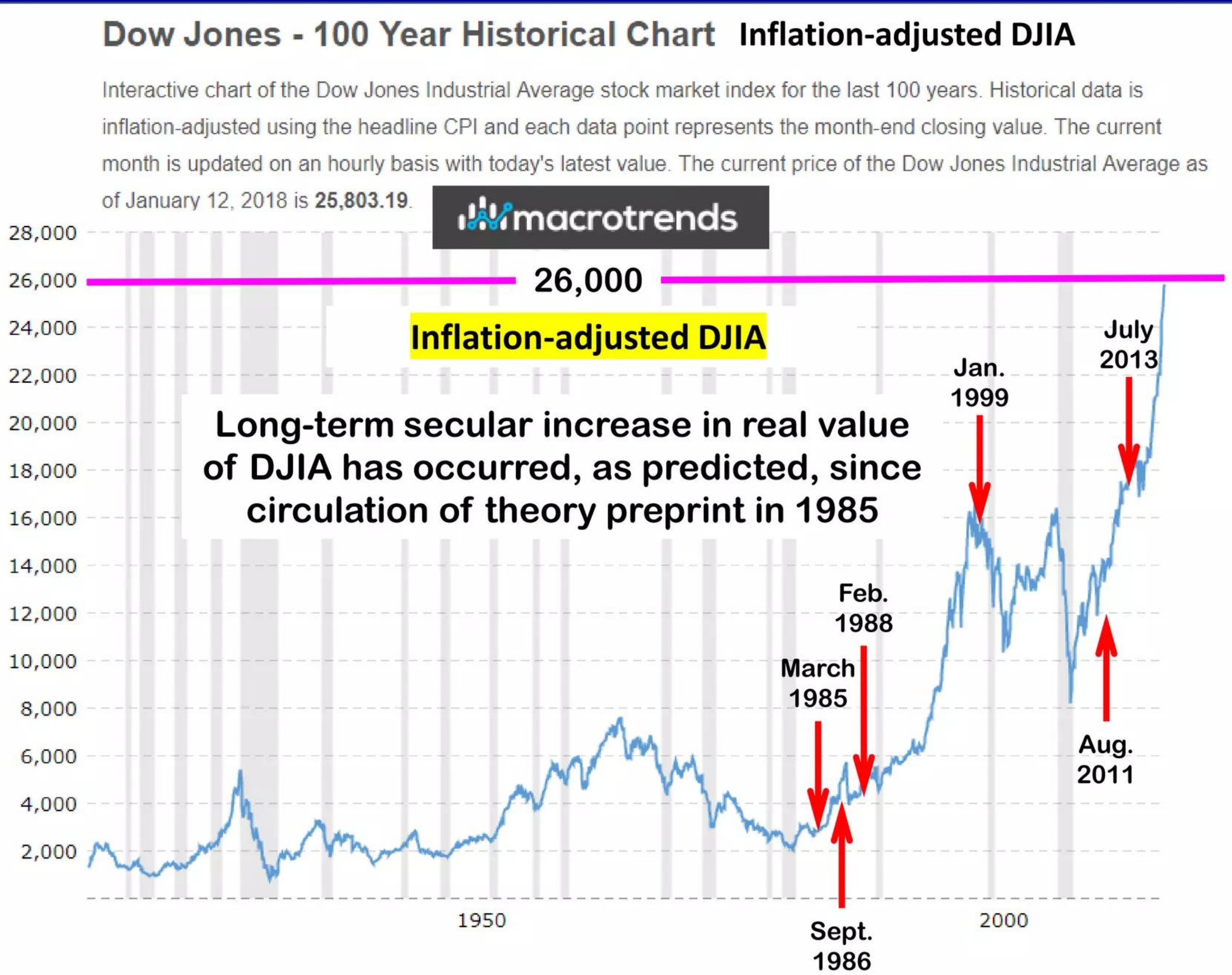
Larsen track record with forecasts reported in 1980s *Barron's* articles April 15, 2012 (pdf copy of 26-page MS-Word document)

https://www.slideshare.net/lewisglarsen/lewis-larsenforecasting-track-record-re-1980s-barrons-articles-by-jon-laingapril-15-2012

"History, LENRs, economics, and the real price of Gold" July 4, 2013 (pdf copy of 60-slide MS-PowerPoint document)

https://www.slideshare.net/lewisglarsen/lattice-energy-llc-historymacroeconomicslenrsand-real-price-of-goldjuly-4-2013

Dates for Larsen qualitative model forecasts shown on chart



Dates for Larsen qualitative model forecasts shown on chart

Macroeconomic theory preprint circulated in March 1985

Value of DJIA was at ~1,270 when 5-page paper was first released

Inflation, Household Asset Preferences, and Economic Policy---
A Simplified View

Lewis G. Larsen
March 10, 1985

Model Conclusions and Implications for Economic Policy

Abstract: *The model predicts that as long as government policies insure that inflation rates do not exceed 3 - 5%, there will be a continuing shift from tangible into financial assets in household portfolios. This shift will in turn create a secular decline in interest rates and a secular uptrend in the stock market. Oscillations around these trends will be determined by "normal" business cycles and fine-tuning of monetary and fiscal policies. The presence or absence of large federal budget deficits cannot prevent this evolution of events as long as inflation is in check.* Deficits are not inflationary as long as they are not monetized. However, deficits can keep interest rates higher than they would otherwise be. This in turn reduces liquidity which slows down the rate of this shift. The model argues that the deficits are not the cause of the high interest rates we are still experiencing. The real cause is a combination of the: long lag in inflationary expectations; illiquidity in household portfolios, banks, and corporations; and a monetary policy that has been too tight during the past year. Outside of printing money and monetizing a debt bail-out, there are no simple, quick solutions to current liquidity problems. Given households' reluctance and inability to either liquidate or further leverage their primary tangible asset --- their houses, the only way they can restructure and re-weight their portfolios is through allocation of a portion of their current and future income. That income can only be provided through economic growth.

Forecast secular increase in stocks & decline in bond yields

Larsen model: decadal household asset shifts are one key driving force

March 1985 – selected quotes from widely circulated theory preprint:

- **"Over the past 80 - 100 years, households could choose between the following asset categories --- financial assets such as stock, bonds, money market instruments, life insurance, annuities, fixed-rate passbook savings and cash; tangible assets such as real estate, personal possessions, antiques, art, other collectibles and commodities such as gold and silver."**
- **"Inflation has a major impact on asset preference shifts, mainly in terms of relative weighting of tangible versus financial assets in the portfolio. Government tax policies that incorporate capital gains and/or income sheltering can have a powerful impact upon relative asset preferences."**
- **"Given an empirical limitation on the rate of return on corporate capital, as inflation rises and the spread narrows between the expected inflation rate and the corporate return, households start shifting out of stocks and into tangibles or (with financial deregulation) money market instruments."**

As inflation expectations decline over time, households slowly shift from tangible assets like real estate and Gold back into financial assets such stocks and bonds or other newer types of financial instruments (Bitcoin?)

Forecast secular increase in stocks & decline in bond yields

Proper U.S. government fiscal and monetary policies can control inflation

March 1985 - selected quotes from widely circulated theory preprint:

- **"The model predicts that as long as government policies insure that inflation rates do not exceed 3 - 5%, there will be a continuing shift from tangible into financial assets in household portfolios. This shift will in turn create a secular decline in interest rates and a secular uptrend in the stock market."**
- **"Oscillations around these trends will be determined by 'normal' business cycles and fine-tuning of monetary and fiscal policies. The presence or absence of large federal budget deficits cannot prevent this evolution of events as long as inflation is in check. Deficits are not inflationary as long as they are not monetized."**
- **"Last assumption is that inflation is an exogenous economic variable with political roots. Inflation originates in government monetary and fiscal policies that are consciously tolerated by the participants in the economy --- households, business, and government. Not that external price shocks, such as oil in 1973-74 and 1979, cannot worsen inflation --- they do, but such events in and of themselves are not the root cause of it. History shows that inflation can be controlled whenever the national political will to do so exists."**

Household inflation expectations began downtrend in ~ 1981

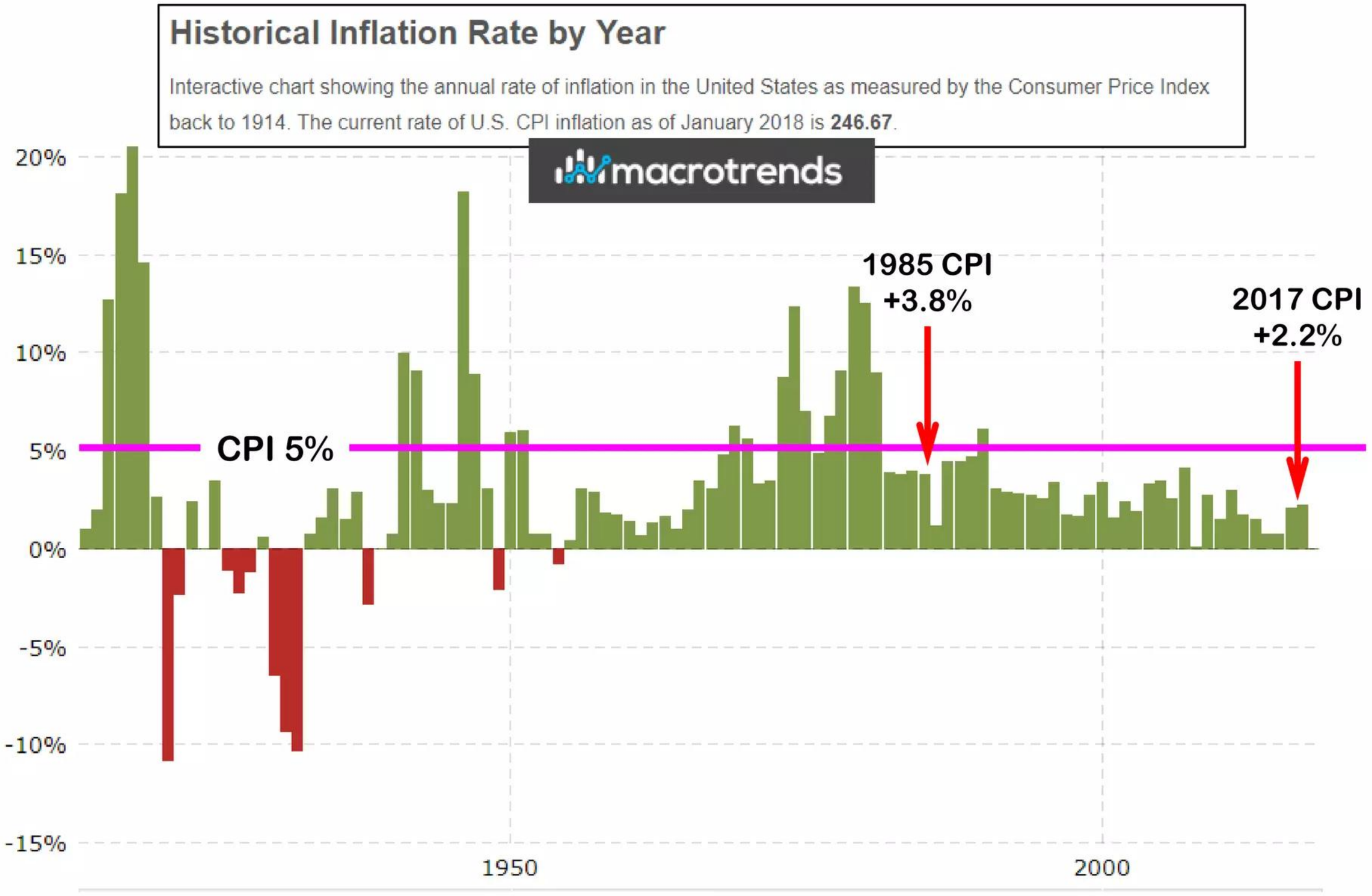
Households will always have non-zero holdings in all asset categories

March 1985 - selected quotes from widely circulated theory preprint:

- **"From all of this, one would expect that both the secular trend and level of bond yields should lag inflation as it accelerates and substantially exceed it as it declines, especially if the decline is rapid. That is exactly what history shows."**
- **"The secular uptrend in long-term bond yields has been broken within the past few years. Since bond supplies must 'clear' each year, this model would indicate that household inflation expectations have finally begun a downtrend after an uptrend lasting many years. Current measured inflation rates must continue to stay low for this to be lasting."**
- **"Given that both stocks and bonds are favorable choices relative to inflation expectations, how do households allocate capital between them? Bonds should be favored at taxable yields over 13%. At taxable yields of 11 - 13%, bonds and stocks should be in rough competitive equilibrium. As taxable bond yields drop below 11%, stocks should be increasingly favored. Households always hold some bonds *regardless* of these relationships."**

U.S. gov't policies since 1985 have kept inflation rate < 3 - 5%

Proper U.S. government fiscal and monetary policies did control inflation

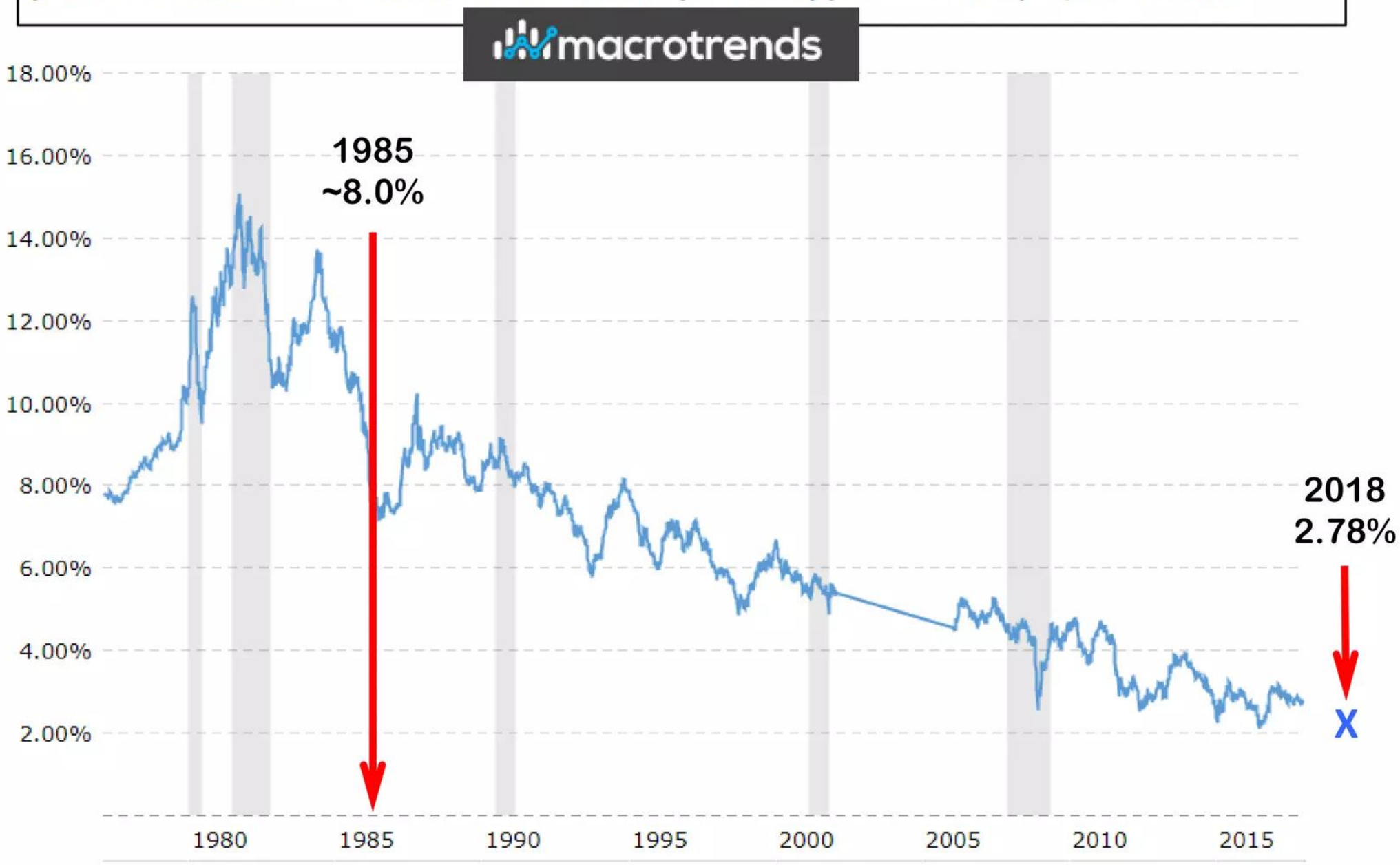


Secular decline: 30-year U.S. Treasury bond yields since 1985

Substantial decline in long-term bond yield forecast by qualitative model

30 Year Treasury Rate - 39 Year Historical Chart

Interactive chart showing the daily 30 year treasury yield back to 1977. The U.S Treasury suspended issuance of the 30 year bond between 2/15/2002 and 2/9/2006. The current 30 year treasury yield as of January 05, 2018 is **2.78%**.



Secular decline: 3-month U.S. Treasury bill yields since 1985

Substantial decline in 3-month T-bill yields forecast by qualitative model

3-month U.S. Treasury bill rate – 60 year Historical Chart

Secular decline: U.S. Aaa corporate bond yields since 1985

Substantial decline in corporate bond yield forecast by qualitative model

FRED ECONOMIC DATA | ST. LOUIS FED — ECONOMIC RESEARCH, FEDERAL RESERVE BANK OF ST. LOUIS

Rating	Long-term ratings
Aaa	Rated as the highest quality and lowest credit risk.

Barron's magazine article published September 1, 1986

Value of DJIA at ~1,800 when these ideas were reported ~32 years ago

BARRON'S

September 1, 1986

Thomas Hart Benton

Lewis Larsen

David Barnes

Shining Prophecy

The Coming Renaissance of U.S. Industry

By JONATHAN R. LAING

Forecast strong boost in U.S. productivity & competitiveness

Drastic reduction in wage-driven inflation will assist reindustrialization

Sept. 1986 – selected quotes from *Barron's* article:

- **"For according to Larsen, this country stands on the verge of a leap in productivity that may be as profound as the Industrial Revolution was to 19th century Europe."**
- **"A stock market bull since the early 'Eighties, he sees the Dow Jones Industrial average reaching at least 3,000 by 1990 and soaring far higher in the ensuing decade."**
- **" … the gap between U.S. and Japanese labor costs has begun to narrow dramatically, not only because of the decline of the dollar but also ebbing union strength, worker give-backs, improved productivity, a growth in group profit-incentive systems and new, less confrontational labor management relationships, says Larsen."**
- **"What I'm talking about is a reindustrialization of America that will propel many of our basic industries such as autos, chemicals, and general manufacturing back into the undisputed world leadership that our computer, aerospace, and biotechnology industries presently enjoy … All the building blocks are in place --- technological breakthroughs, a well-developed capital market, a huge domestic market and ample resources."**

U.S. has key competitive advantage in technology innovation

Advanced technology will allow U.S. to compete with low-wage countries

Sept. 1986 – selected quotes from *Barron's* article:

- "Larsen believes that the doom and gloom crowd also tends to give short shrift to enormous strides U.S. companies have made in pruning costs and lowering breakeven points while improving product quality. Whole layers of redundant white-collar workers have been chopped."
- "[Larsen] contends that the U.S. has a significant edge in technological innovation to not only more than match Japanese manufacturers but also to leapfrog cheap labor competition in such areas as Korea and Brazil."
- "Though Japan enjoys a lead in robotic manufacturing , Larsen claims that that the U.S. will overtake it because of the U.S.'s lead in 'machine vision,' artificial intelligence, and developing software to link hierarchies of computers."
- "These various technological advances aren't pie in they sky stuff ---they're happening … "The resulting automation and jump in productivity could nearly drop labor content out of the production-cost equations and spawn whole new industries and products in the 'Nineties."

U.S. productivity increased greatly by 2017, just as forecast

Significant acceleration began in 1990; flat since Great Recession of 2008

"The BLS' index of labor productivity for manufacturing is two and a half times higher than it was at the beginning of 1987 … After adjusting for inflation, manufacturing output in the first quarter of this year was more than 80% above its level 30 years ago, according to BLS data. "

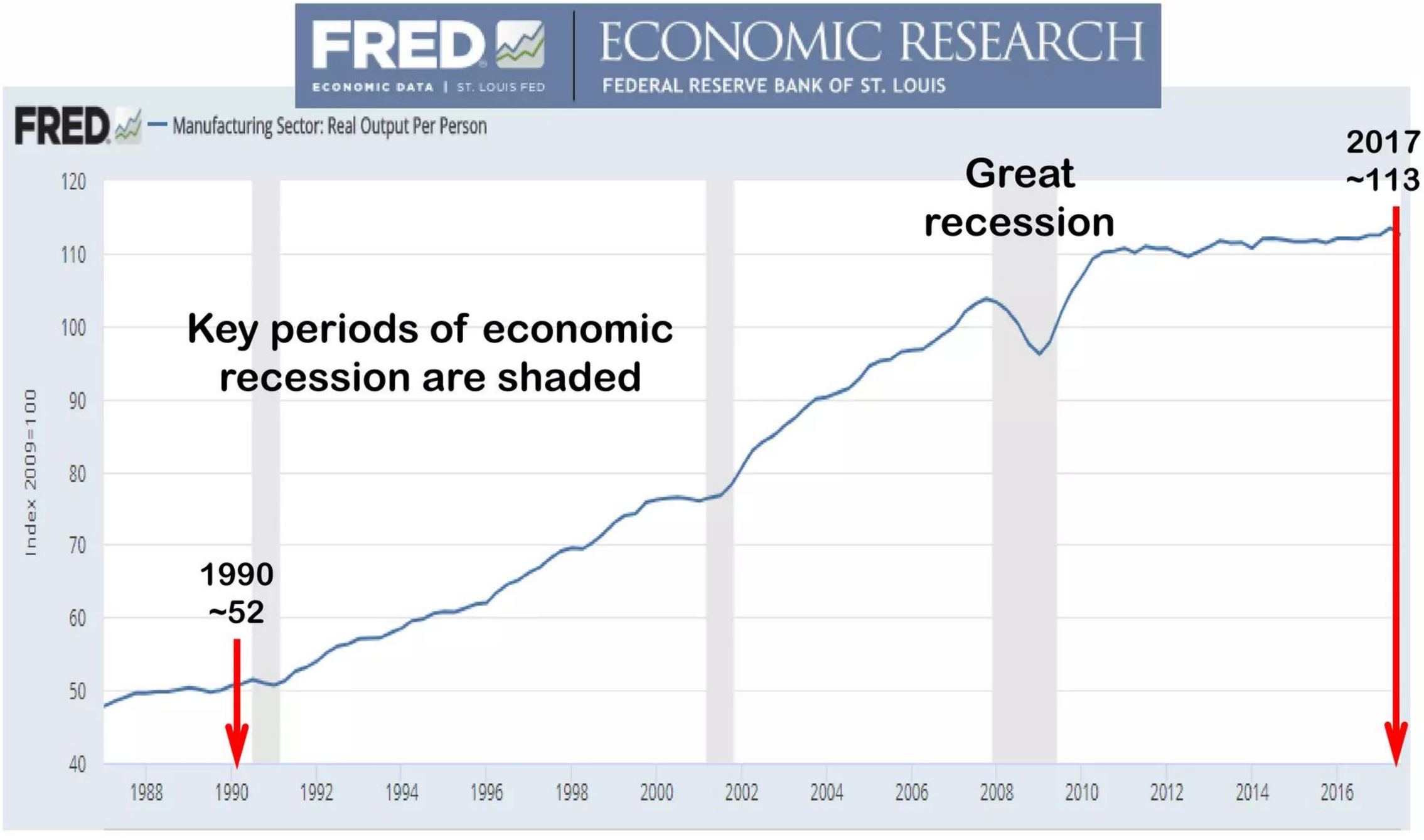
Source: "Most Americans unaware that as U.S. manufacturing jobs have disappeared, output has grown"

Drew Desilver for Pew Research Center July 25, 2017

http://www.pewresearch.org/fact-tank/2017/07/25/most-americans-unaware-that-as-u-s-manufacturing-jobs-have-disappeared-output-has-grown/

U.S. real manufacturing output per worker increased greatly

Substantial rate increase began in 1990; flat since 2008 Great Recession

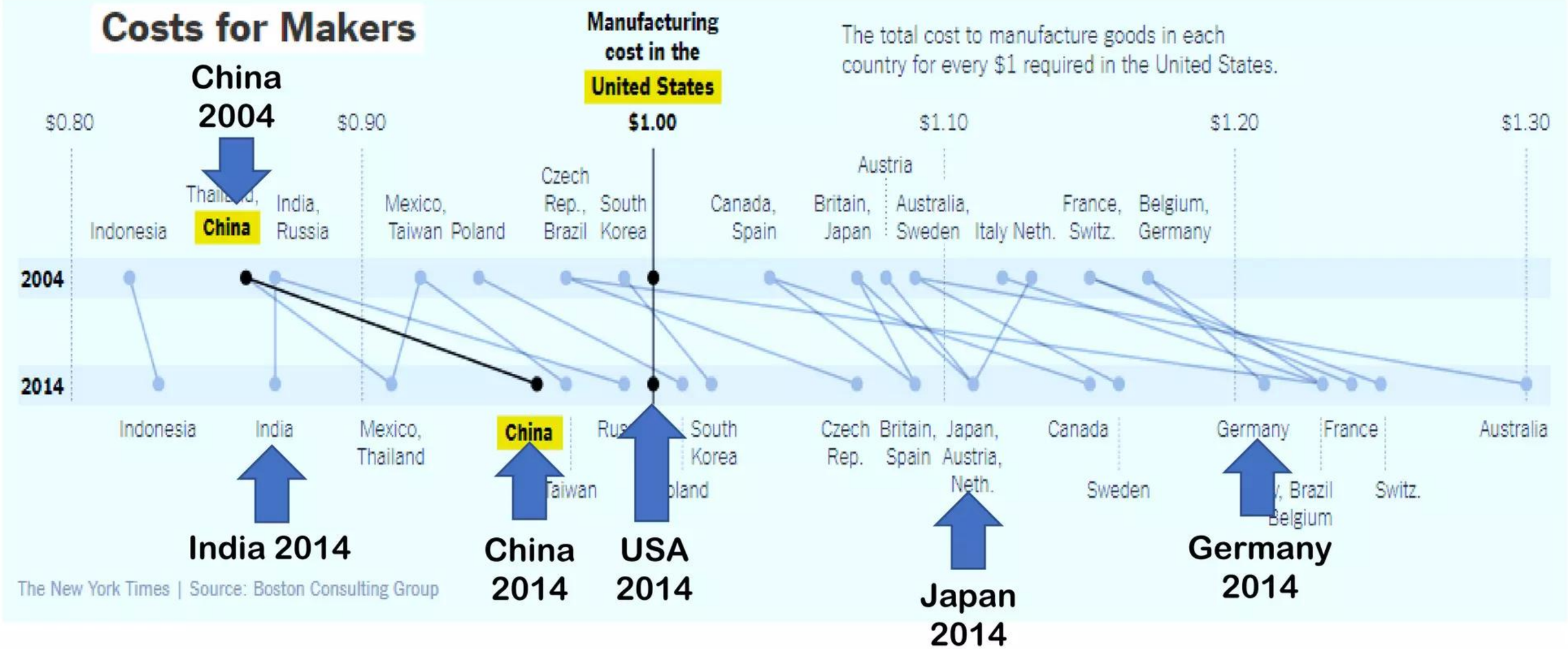


Japan's manufacturing costs now > USA, as forecast in 1986

As of today, China's costs are rising and only slightly lower than in USA

The New York Times

Manufacturing costs rose from 2004 to 2014 in most of the top 25 exporting countries. Some that are usually thought of as cheap places to produce goods like Russia, Taiwan and **China** now have costs pretty close to those in the **United States**.



https://www.nytimes.com/interactive/2015/07/31/business/international/rising-cost-of-manufacturing.html

U.S. manufacturing is competitive again, as forecast in 1986

Japan, China, and other key competitors lost prior labor cost advantages

bcg.perspectives
by THE BOSTON CONSULTING GROUP

"Honing US manufacturing's competitive edge" H. Sirkin, J. Rose, and R. Choraria
The Boston Consulting Group *BCG Perspectives* January 11, 2017

- **"Offshoring has dropped dramatically, particularly with regard to the world's biggest workshop: China … The main reason for this change is economics. As The Boston Consulting Group has documented, the cost competitiveness of US manufacturing has been improving significantly over the past decade, compared with many of its biggest trading partners --- most notably China."**

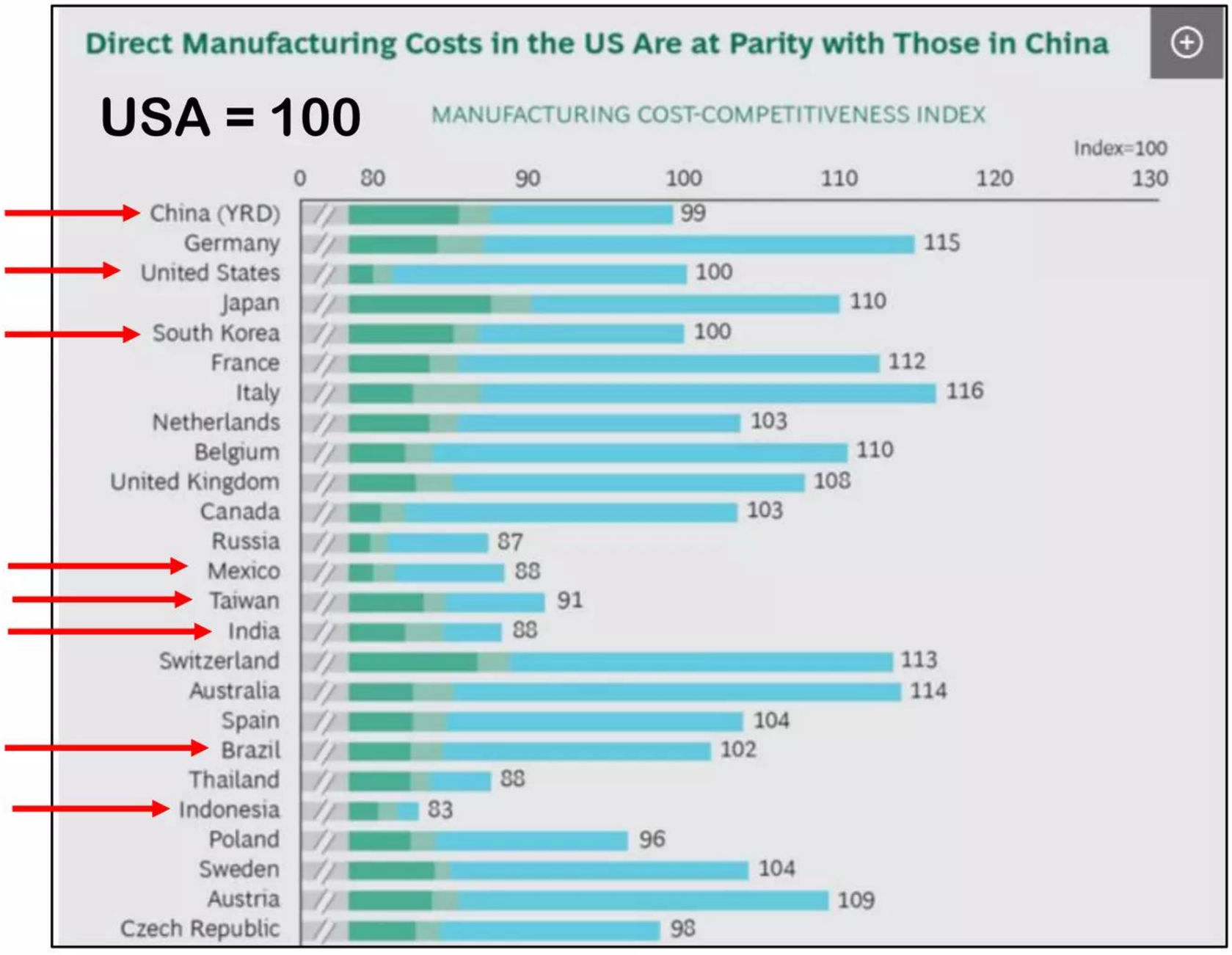
- **"In terms of direct costs, in fact, the US playing field is essentially level with Yangtze River Delta, China's chief production zone. Despite the recent weakening of the yuan, and factoring in the differences in productivity and energy costs, China's manufacturing cost advantage over the US shrank from 14% in 2004 to an insignificant 1% in 2016, according to our analysis of data collected for the BCG Global Manufacturing Cost- Competitiveness Index … When indirect costs for shipping, inventory, and other expenses are included, it is now less costly to manufacture a wide variety of goods in the US if that is where they will be consumed."**

https://www.bcg.com/publications/2017/lean-manufacturing-operations-honing-us-manufacturings-competitive-edge.aspx

BCG exhibit compares countries' direct manufacturing costs

As of 2017: U.S. less expensive vs. Brazil & only slightly > Mexico & India

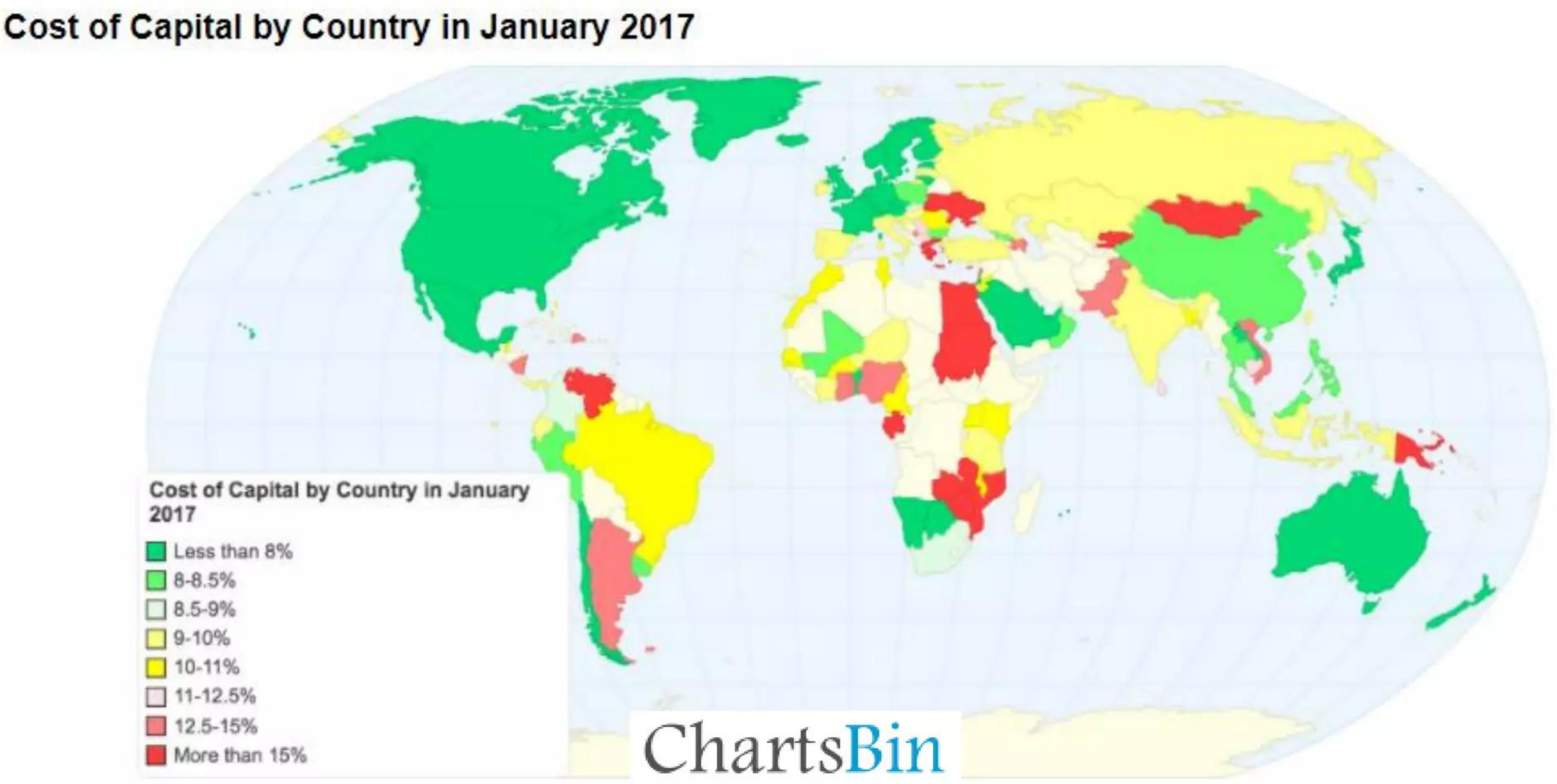
bcg.perspectives
by THE BOSTON CONSULTING GROUP



https://www.bcg.com/publications/2017/lean-manufacturing-operations-honing-us-manufacturings-competitive-edge.aspx

United States now highly competitive with its cost of capital

Corporations with Aaa-rated debt can finance long-term projects at < 4%



http://chartsbin.com/view/43659

Detroit is having competitive comeback, as forecast in 1986

India, which is now lower-cost than China, builds new auto plant in U.S.

"Indian automaker's plant is latest sign of Detroit comeback"

Bill Vlasicnov *The New York Times* Nov. 20, 2017

- **"It has been years since Detroit, birthplace of the American auto industry, was a steady producer of the manufacturing jobs that defined it as the Motor City. But its comeback is entering a new phase."**
- **"Latest milestone came Monday, with the announcement of the area's first new vehicle assembly plant in 25 years. And the automaker making it happen is from, of all places, India. The company, the Mumbai-based Mahindra Group, said it would begin producing off-road recreational and work vehicles at the plant, in Auburn Hills, early next year. And it indicated that this might be just a first step in its ambitions for the American market."**
- **"The factory underscores that the Detroit area is again attracting automotive investment. The region is still a prime source of engineering talent and manufacturing know-how, as well as a technology incubator for electric cars and self-driving systems. Mahindra already has a design and engineering center in Troy, half an hour north of Detroit, that turns out prototypes of future vehicles. Other foreign companies have also made big investments in the Detroit area and throughout the upper Midwest."**

https://www.nytimes.com/2017/11/20/business/detroit-indian-automaker.html

U.S. is competitive on factors affecting investment decisions

Trump regulation rollbacks and tax rate cuts boost U.S. competitiveness

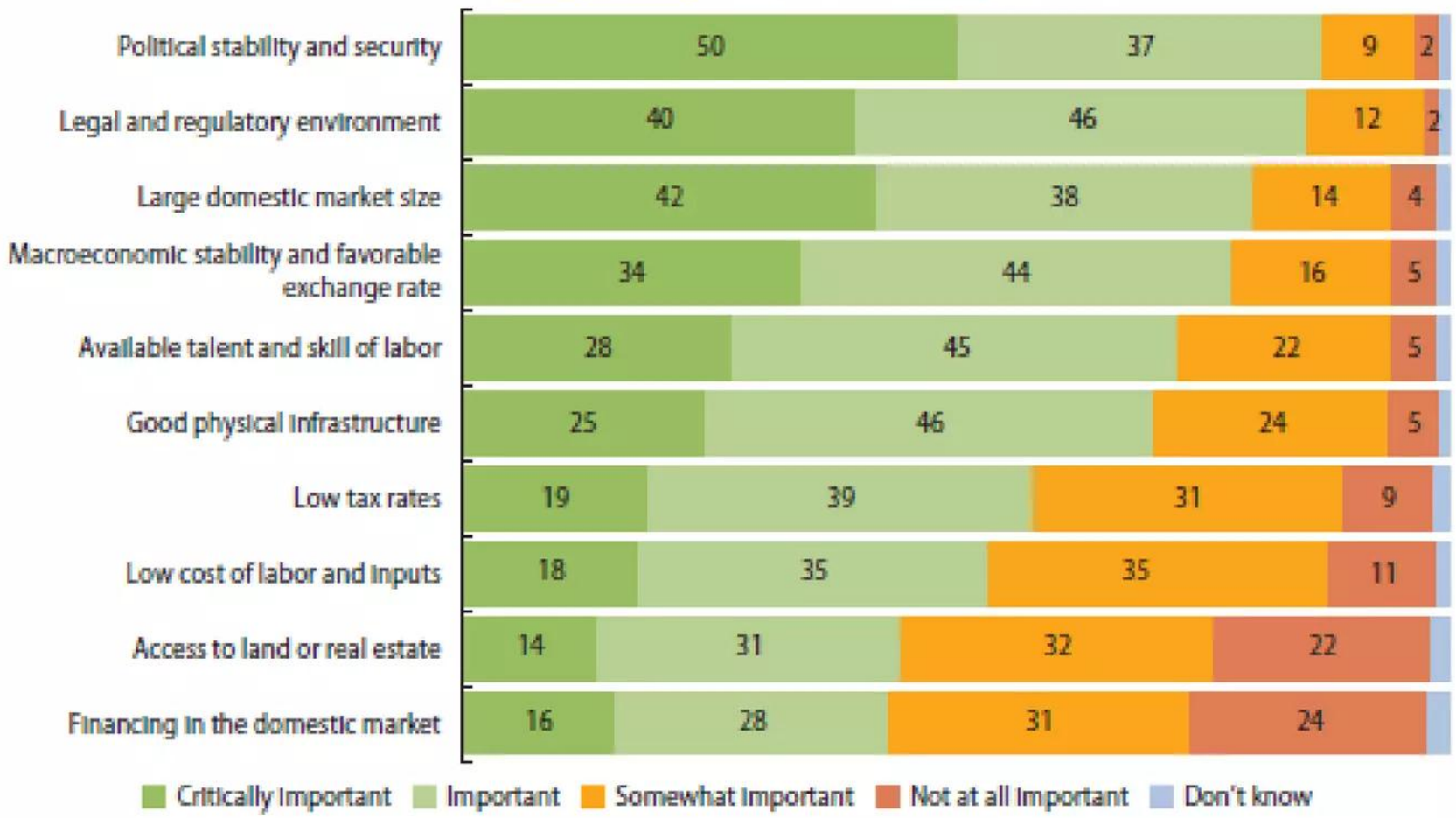
WORLD BANK GROUP

FIGURE O.3 Factors Affecting Investment Decisions

Share of respondents (percent)

2017 | 2018 GLOBAL INVESTMENT COMPETITIVENESS REPORT

Page 22



Source: Computation based on the GIC Survey.

Note: Multinational corporation executives were asked how important these characteristics were in their decision to invest in developing countries.

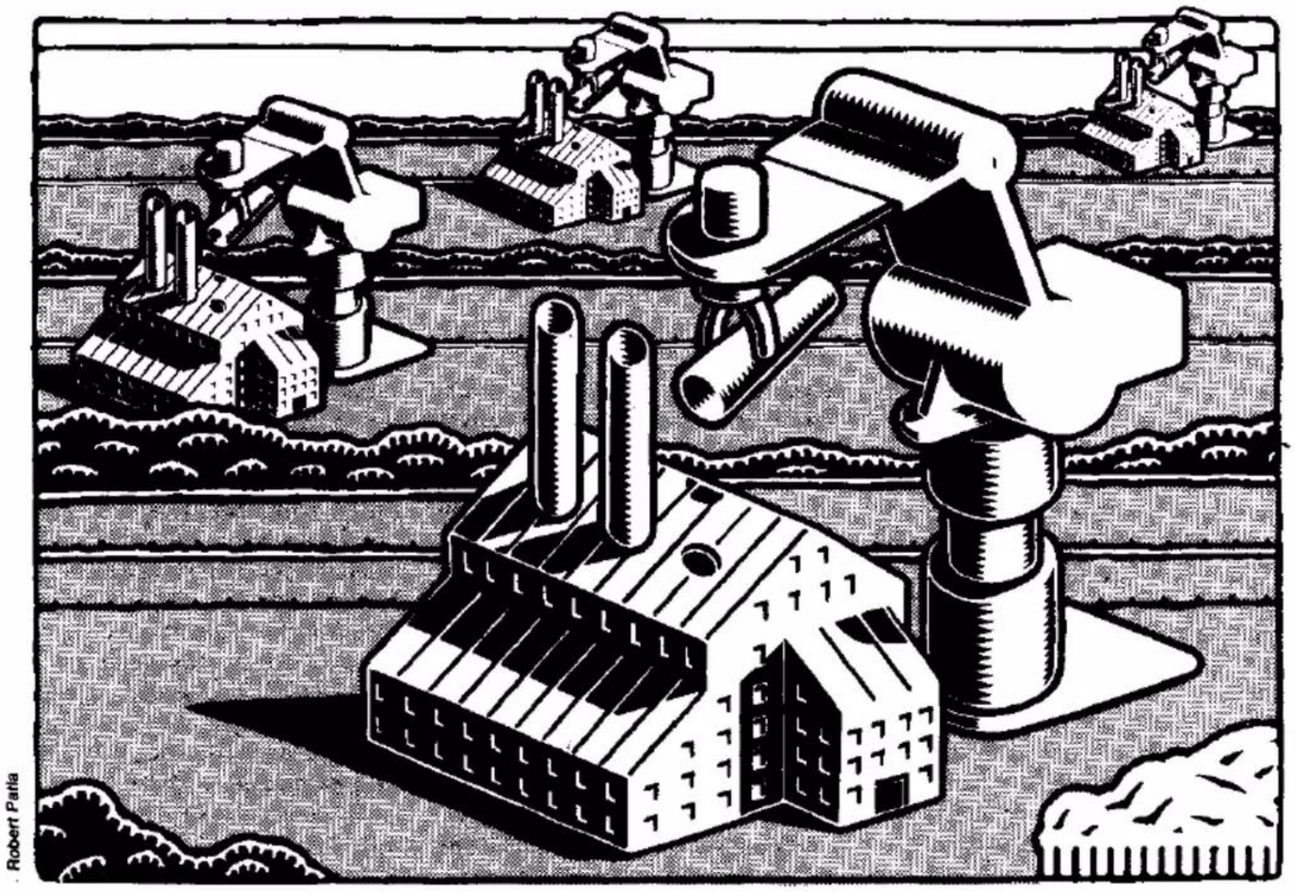
http://documents.worldbank.org/curated/en/169531510741671962/pdf/121404-PUB-PUBLIC-PUBDATE-10-25-2017.pdf

Barron's magazine article was published February 1, 1988

Value of DJIA at ~ 1,945 when these ideas were reported 30 years ago

BARRON'S

February 1, 1988



Robert Patia

Back to the Futurist

Lewis Larsen Says We Ain't Seen Nothin' Yet

By JONATHAN R. LAING

Present macroeconomic environment resembles late-1800s

19th century experienced financial panics and large economic downturns

Feb. 1988 – selected quotes from *Barron's* article:

- **"All of this excites Larsen mightily. He scoffs at the self-appointed pundits who are now predicting a reply of the Great Depression. If anything, he thinks the present era resembles closely the 1880s and 1890s, when the U.S's agrarian society gave way to the Industrial Revolution."**
- **"He [Larsen] cites numerous parallels. Both periods saw significant bursts in technological innovation. He points excitedly to two tidal waves in his chart of new patents issued almost 100 years apart. The breakthroughs in the late 19th century in electricity, telegraphy, automobiles, the diesel engine, frame construction, radio, and steam-powered shipping laid the basis for modern industrial society, he declares."**
- **"Both periods also have witnessed major pulses of net immigration which drew in not only cheap labor but also scientific and technical talent from outside the U.S. Likewise, the U.S. incurred heavy foreign debts during both eras in building up its productive capacity and infrastructure, according to Larsen."**
- **"Then as now economic instability reigned … last quarter of … 19th century was punctuated by financial panics and severe economic contractions … economic downturns have … analogues in the post-1973-era, according to Larsen."**

Asserted U.S. will dominate next phase of industrial evolution

Robots are now invading many different types of industries, as forecast

Feb. 1988 – selected quotes from *Barron's* article:

- **"Huge labor displacement occurred in both eras which caused naggingly high unemployment and crimped purchasing power despite the enormous increases in worldwide productive capacity, [he] asserts."**
- **"Yet the chaos of the late 19th century spawned arguably the greatest period of economic growth in U.S. history --- the first two decades of the 20th century. This period saw the birth of many of today's industrial behemoths. The Rockefellers, DuPonts and Mellons, for example, made the bulk of their family fortunes during these times."**
- **Larsen believes that just such a golden era may lie ahead for the U.S., though the economy has a way to go before reaching its 'pull-out' phase."**
- **"His bullishness rests on his conviction that just as the U.S. dominated the era of the mass production assembly line, so will it stand astride the next stage of industrial evolution, an age that will see an explosion in computer control of all aspects of production from product design and fabrication to inventory handling, machine and labor scheduling, quality control and shipping."**
- **"Robots are increasingly handling the dull, repetitive jobs of spot welding, painting and assembly."**

Forecast realized by invention of TCP/IP, html and the Internet

Computer integration enabled by invention of World Wide Web in 1993

Feb. 1988 – selected quotes from *Barron's* article:

- **"Larsen insists, though, that the U.S. will have a decided edge in the next crucial step in automation --- computer-integrated manufacturing. In this brave new world, the data and instructions flowing smoothly from production stage to production stage will permit an infinite variety of goods to be made efficiently, and an implosion in product life cycles."**
- **"Computer networks will link customer and supplier symbiotically."**
- **"The key to coming computerized integration is that innovation and production will merge together into a single act," Larsen contends.**
- **"Technological content will become paramount with production efficiency and quality mere givens. That has to be a big boost to the U.S., which has always lead the rest of the world in innovation if not commercial applications."**
- **"Such computer integration depends on elaborate software and systems integration, though. In other words, computers of disparate size, manufacture and function must be made to talk and work together." [forecast realized by invention of TCP/IP, html, and rise of the Internet]**

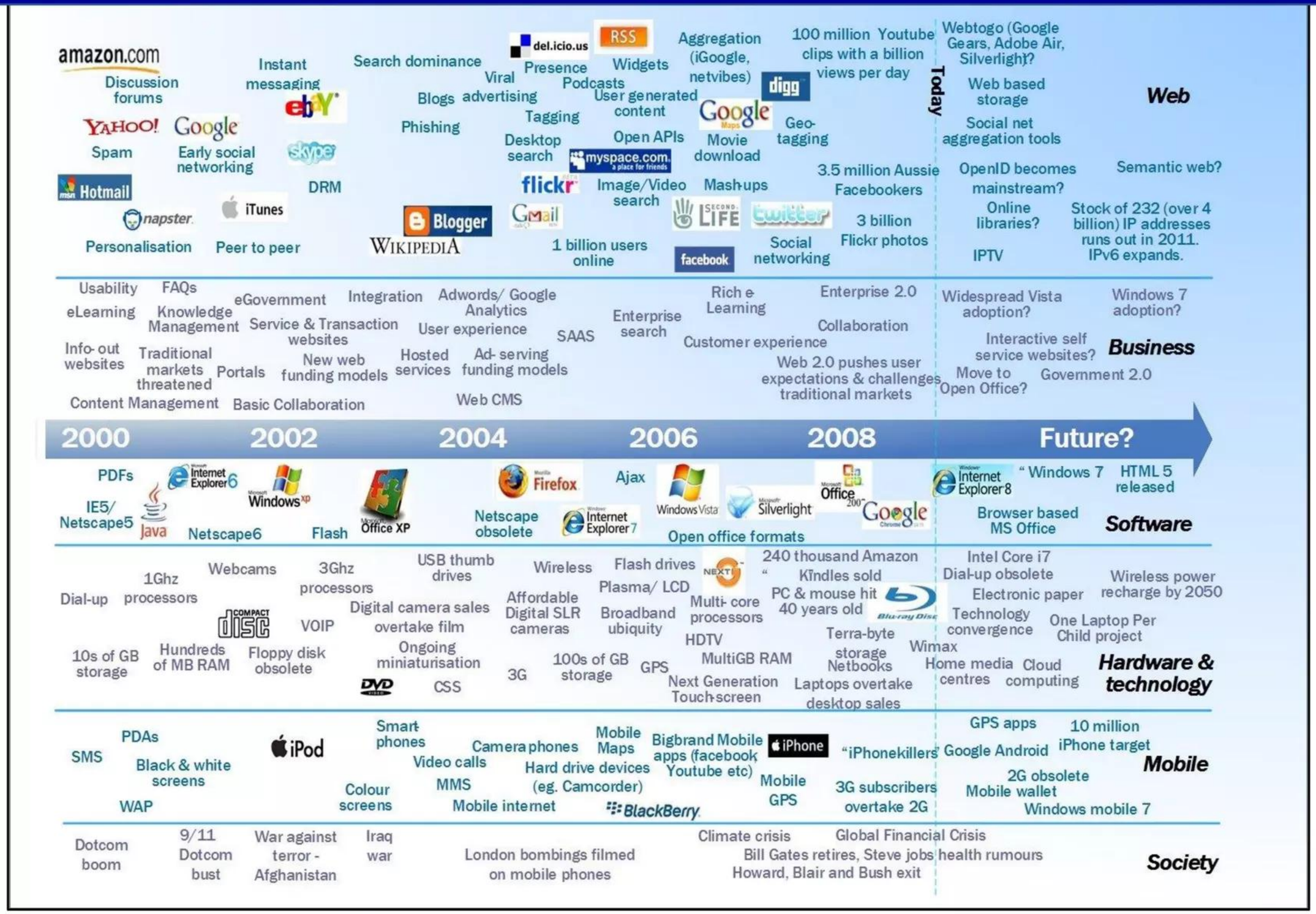
U.S. has major competitive advantage in computer software

Forecast small chance for huge economic calamity like Great Depression

Feb. 1988 – selected quotes from *Barron's* article:

- **"The Japanese may study harder and turn out more engineers per capita than we do, but they can't touch us in the creativity or profusion of our software," he asserts. "Our system seems to breed inventive hackers who turn into brilliant programmers and software writers. And these days, software is power because it embeds knowledge into programs and vastly expands the range of expertise." [now called artificial intelligence or AI]**
- **"To Larsen, the ferocity of the October crash was grossly out of proportion to the events triggering it." "In my estimation, the major cause was the Federal Reserve's monetary tightening, which became apparent to most everybody by August," he contends. [Oct. 19, 1987: "Black Monday" DJIA plunged 508 points or 22.6%; largest-ever single-day % drop in Dow history]**
- **"Larsen sees a less than one-in-three chance of any economic calamity akin to the Great Depression occurring in the next few years. To avoid problems, however, the Fed must follow a neutral-to-expansive monetary policy, whatever its effect on the dollar, he says, and because deflationary pressures still abound, he sees little danger in a relaxed Fed monetary policy reigniting inflation and causing a rise in interest rates."**

Software products and Internet technologies had vast impact



StayOnSearch
Dominate Your Niche. Make More Money.

Chart credit: Mark Thompson

http://www.stayonsearch.com/what-will-the-internet-be-like-in-2025

Robots are presently replacing humans for repetitive tasks

First impacted manufacturing but now spreading into other industries

Example: use of robots increased plant productivity by 250%

Changying Precision Technology Company located near Shenzhen, China

IEEE SPECTRUM

"Chinese unmanned factory replaces 600 humans with 60 robots"
Evan Ackerman *IEEE Spectrum* Aug. 15, 2015

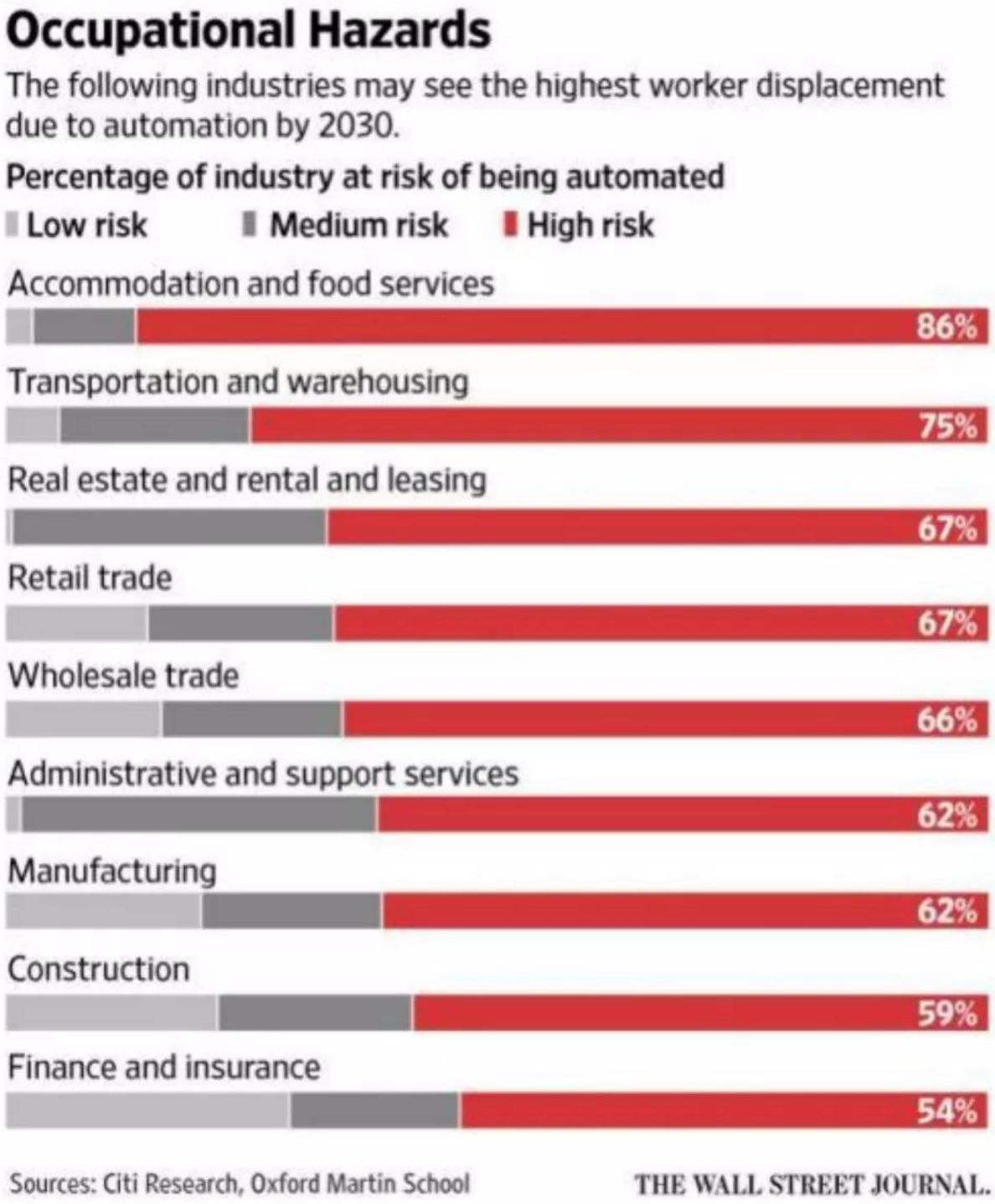
Selected quotes from *IEEE Spectrum* article:

- "Changying Precision Technology Company … has replaced some 600 human assembly line workers with 60 robots, resulting in a fivefold reduction in manufacturing errors and an increase in production of over 250 percent."
- "Other robots in this factory, which manufactures 'cell phone modules,' according to the article, include 'unmanned transport trucks' and some unspecified automated warehouse equipment. The introduction of the robots reportedly improved production capacity from 8,000 modules per person per month to 21,000, and the defect rate has dropped from over 25 percent (!) to under 5 percent."
- "Apparently, there are still some human workers in the factory, but most don't perform any actual assembly line task: the 'technical staff just sits at the computer and monitors through a central control system'."

https://spectrum.ieee.org/automaton/robotics/industrial-robots/chinese-unmanned-factory-replaces-humans-with-robots

Examples: industries where robots & AI are displacing people

Remarkable range of jobs are now vulnerable to advanced automation



Similar to 1800s: will be high levels of labor displacement

Major increases in productivity will ultimately lead to higher real wages

"Robots could replace nearly a third of the U.S. workforce by 2030"

By Danielle Paquette *The Washington Post* Nov. 30, 2017

Selected quotes from *Washington Post* article:

- **"Over the next 13 years, the rising tide of automation will force as many as 70 million workers in the United States to find another way to make money", a new study from the global consultancy McKinsey predicts.**
- **"That means nearly a third of the American workforce could face the need to pick up new skills or enter different fields in the near future", said the report's co-author, Michael Chui, a partner at the McKinsey Global Institute who studies business and economics.**
- **By 2030, the researchers estimated, the demand for office support workers in the U.S. will drop by 20 percent. That includes secretaries, paralegals and anyone in charge of administrative tasks. During the same period … need for people doing 'predictable physical work' — construction equipment installation and repair, card dealing, security guarding, dishwashing and food preparation … will fall by 30 percent."**

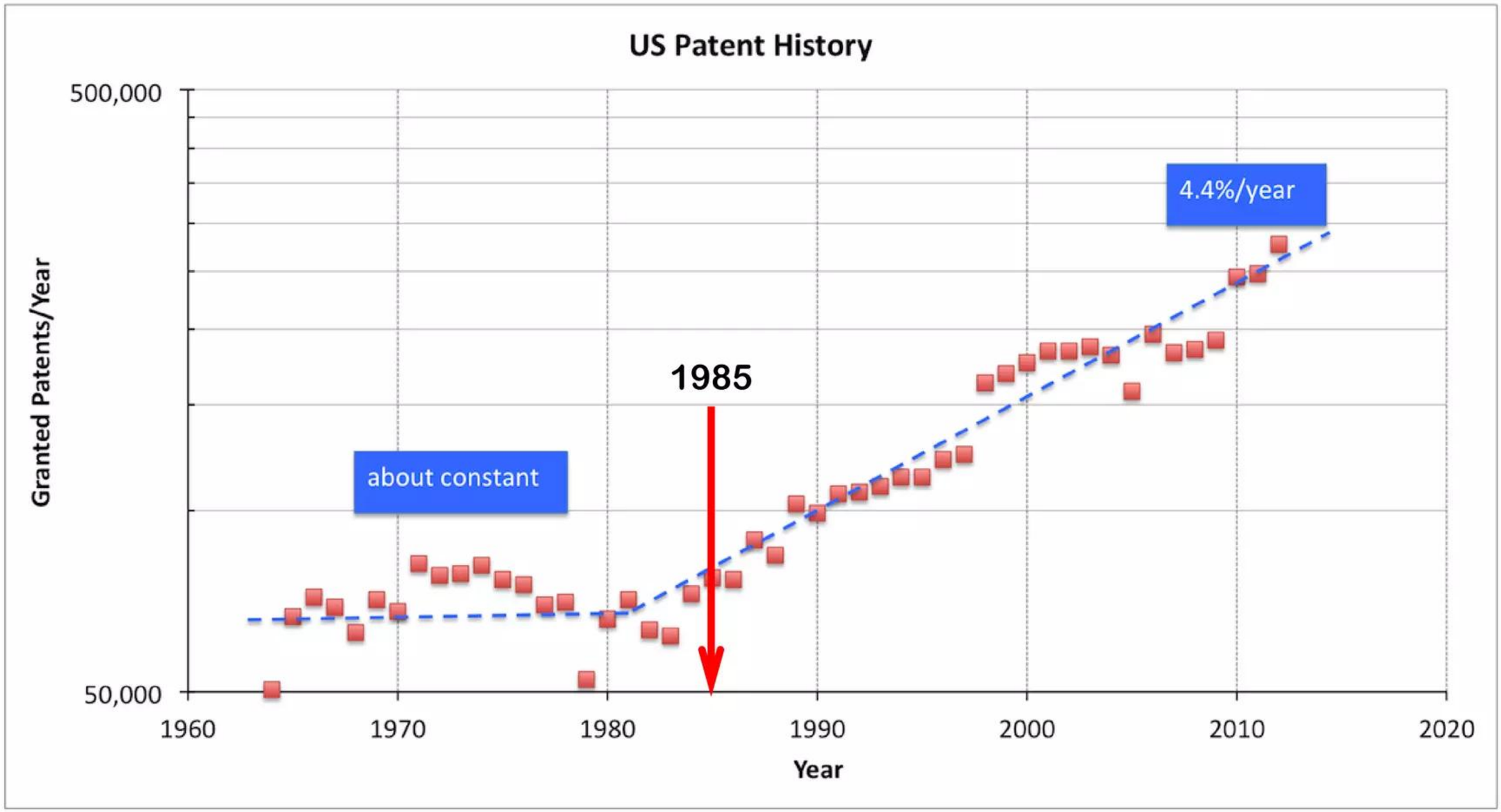
https://www.washingtonpost.com/news/wonk/wp/2017/11/30/robots-could-soon-replace-nearly-a-third-of-the-u-s-workforce/?utm_term=.65888c1b4941

Inventiveness and issuance rates of patent grants are quantitatively related to ongoing rates of technological progress. For major advances, lag-time from first-invention to major market impact of derivative commercial products can be as long as 15 - 20 years

Image credit:
https://en.wikipedia.org/wiki/Scientist

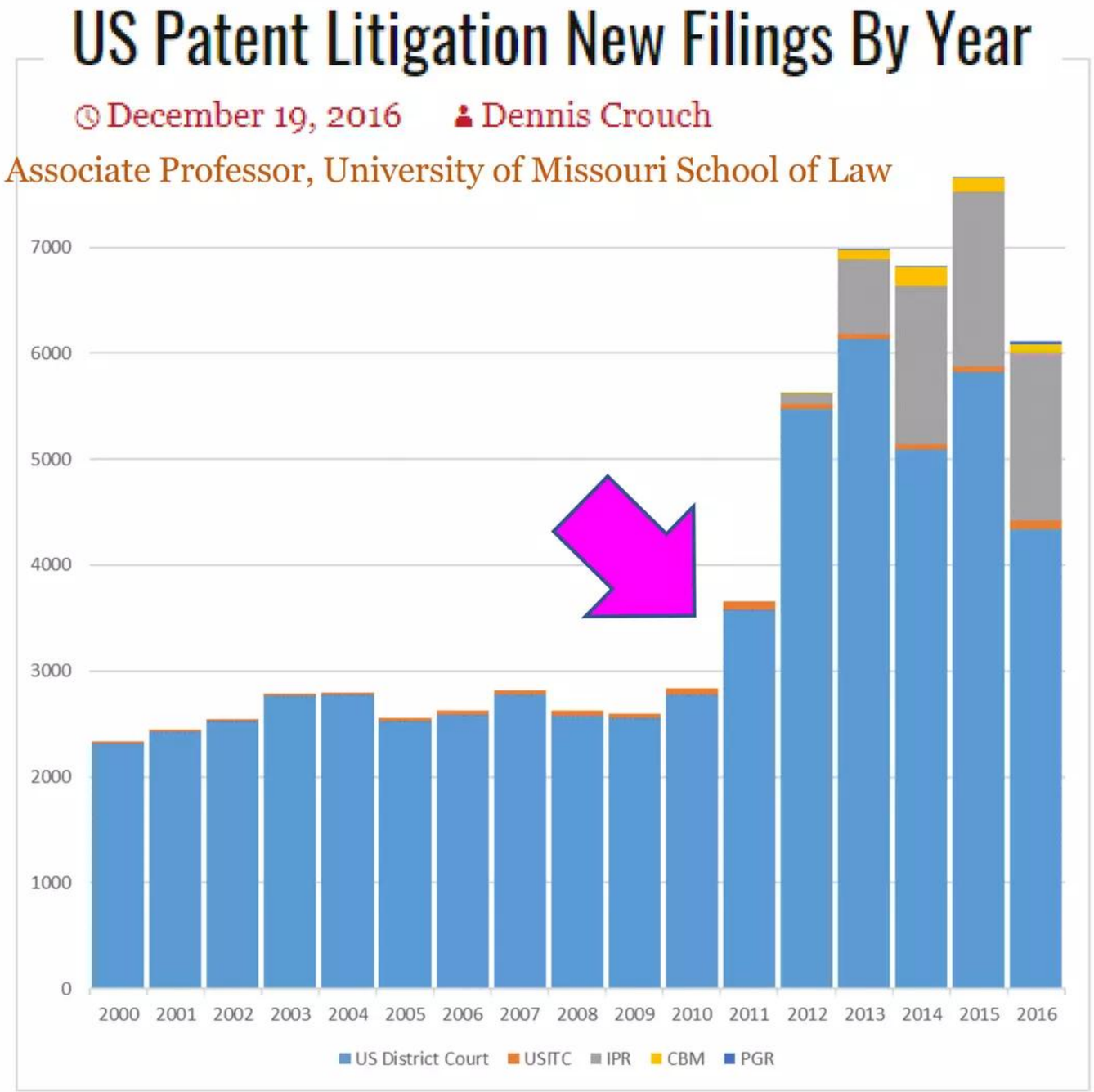
Rate of granting U.S. patents began to accelerate in ~ 1985

Rate changed from being "about constant" to increasing by 4.4% per year



New U.S. patent litigation filings began to explode in 2016

Similar to 19th century when many technological breakthroughs occurred



https://patentlyo.com/patent/2016/12/patent-litigation-filings.html

New U.S. patent litigation filings began to explode in 2016

Beauchamp compares present situation to similar episode in 19th century

ARTICLE

The First Patent Litigation Explosion

Christopher Beauchamp

February 2016

THE YALE LAW JOURNAL

- **Abstract: "The twenty-first century 'patent litigation explosion' is not unprecedented. In fact, the nineteenth century saw an even bigger surge of patent cases. During that era, the most prolific patent enforcers brought hundreds or even thousands of suits, dwarfing the efforts of today's leading 'trolls'."**
- **"In 1850, New York City and Philadelphia alone had ten times more patent litigation, per U.S. patent in force, than the entire United States in 2013. Even the absolute quantity of late-nineteenth-century patent cases bears comparison to the numbers filed in recent years: the Southern District of New York in 1880 would have ranked third on the list of districts with the most patent infringement suits filed in 2014 and would have headed the list as recently as 2010."**
- **"This Article reveals the forgotten history of the first patent litigation explosion. It first describes the rise of large-scale patent enforcement in the middle of the nineteenth century … The effects of the litigation explosion were profound."**

https://www.yalelawjournal.org/pdf/n.848.Beauchamp.944_dywbcn97.pdf

Chart shows rates of U.S. patent litigation back to 1830

So far, recent "explosion" is less than 1800s; will it accelerate in future?

ARTICLE

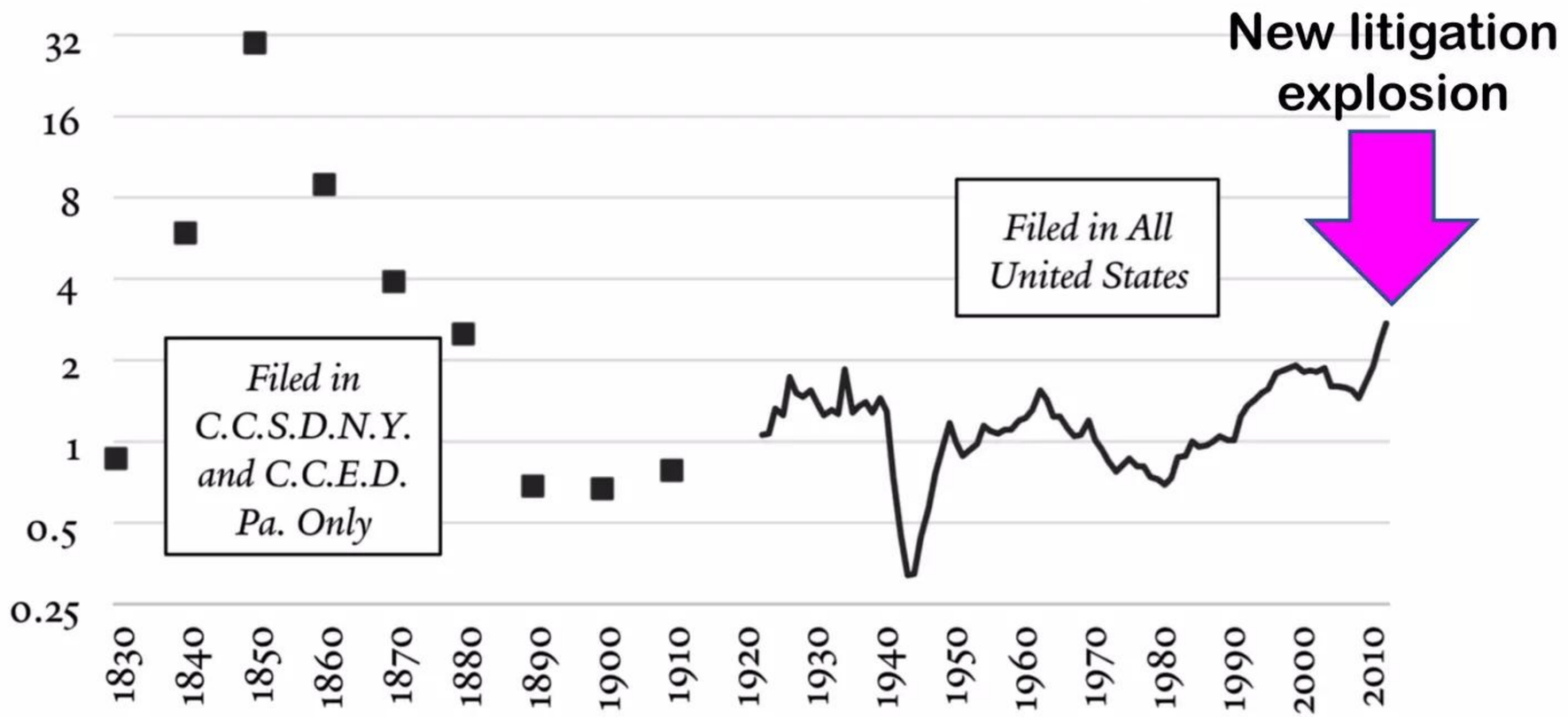
The First Patent Litigation Explosion

Christopher Beauchamp

February 2016

THE YALE LAW JOURNAL

FIG. 4 RATES OF PATENT LITIGATION PER THOUSAND U.S. PATENTS IN FORCE, SOUTHERN DISTRICT OF NEW YORK AND EASTERN DISTRICT OF PENNSYLVANIA, SAMPLE YEARS 1830-1910, AND ALL U.S. DISTRICTS, SAMPLE YEARS 1923-2013 (LOG SCALE ON Y-AXIS)



U.S. Patent Suits Filed per 1,000 U.S. Patents in Force, Sample Years 1923-2013

Patent Suits Filed in the C.C.S.D.N.Y. and C.C.E.D. Pa. per 1,000 U.S. Patents in Force, Sample Years 1830-1910

https://www.yalelawjournal.org/pdf/n.848.Beauchamp.944_dywbcn97.pdf

Worldwide rates of patent grants increased vastly since 1979

Especially large accelerations have occurred with USA, China, and Japan

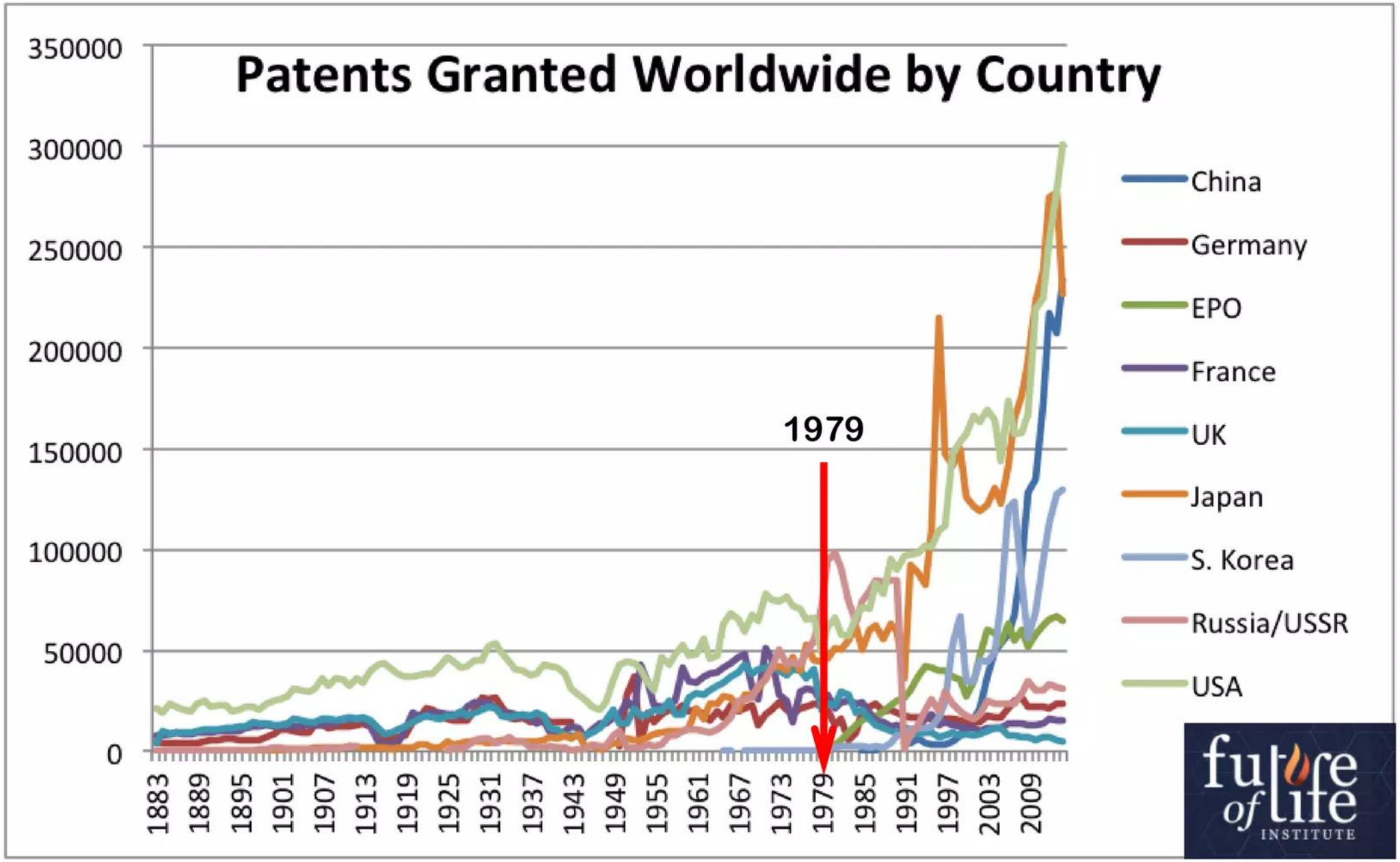


Chart credit: Eric Gastfriend

https://futureoflife.org/2015/11/05/90-of-all-the-scientists-that-ever-lived-are-alive-today/

Worldwide # of new PhDs began growing even faster in ~1985

Increasing population of PhDs boosts rates of technological innovation

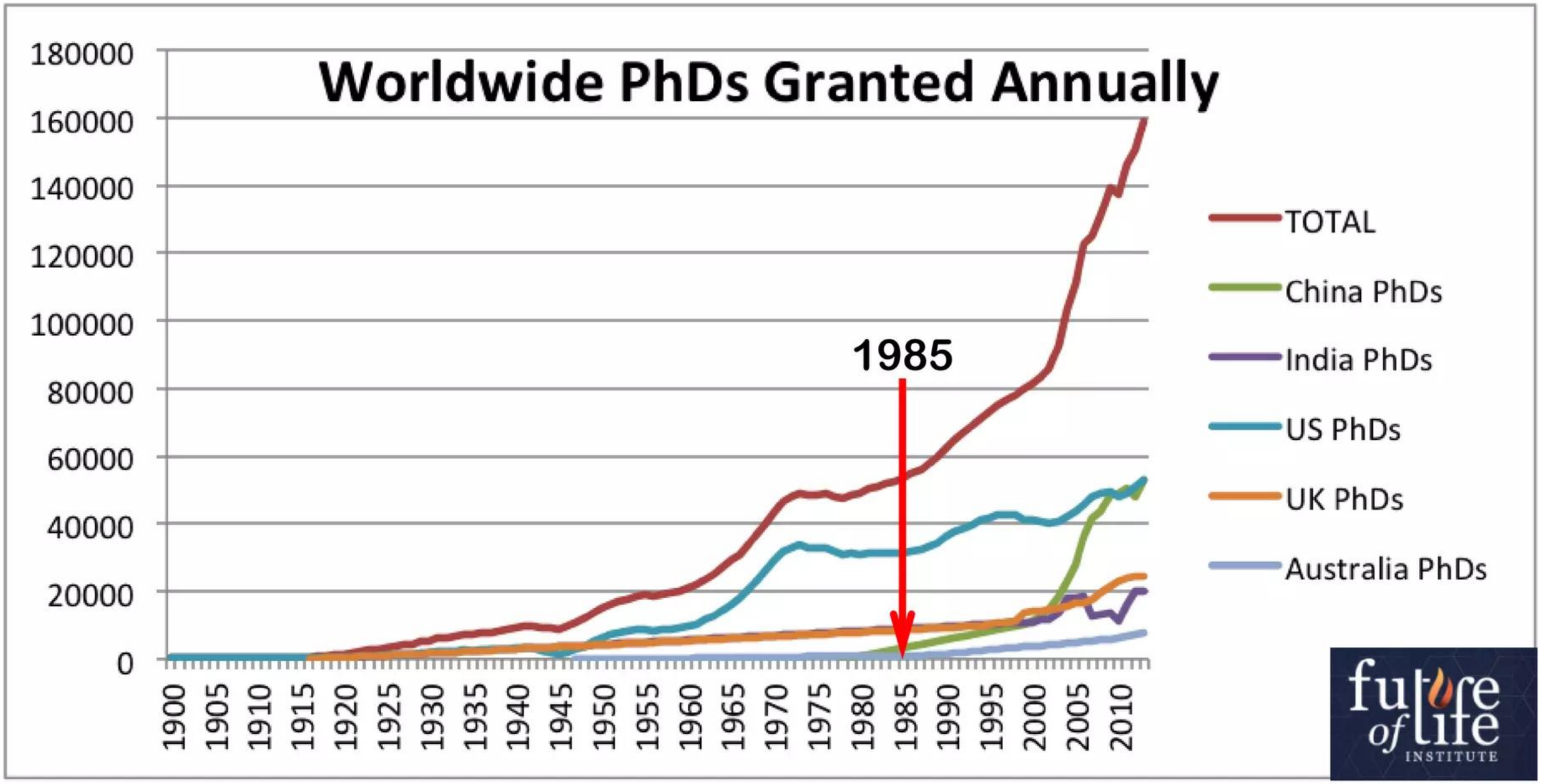
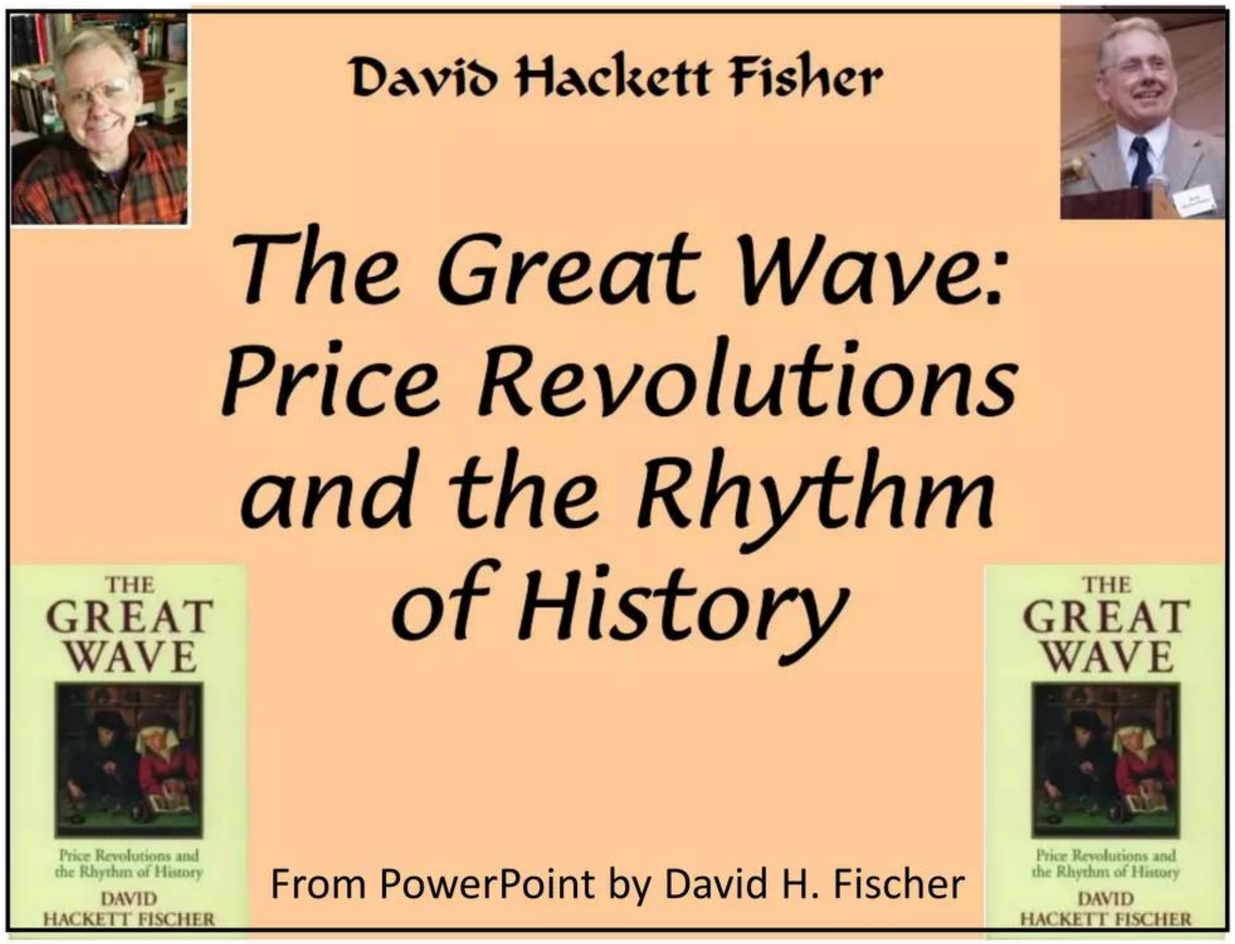


Chart credit: Eric Gastfriend

https://futureoflife.org/2015/11/05/90-of-all-the-scientists-that-ever-lived-are-alive-today/

Historian David H. Fischer published important book in 1996



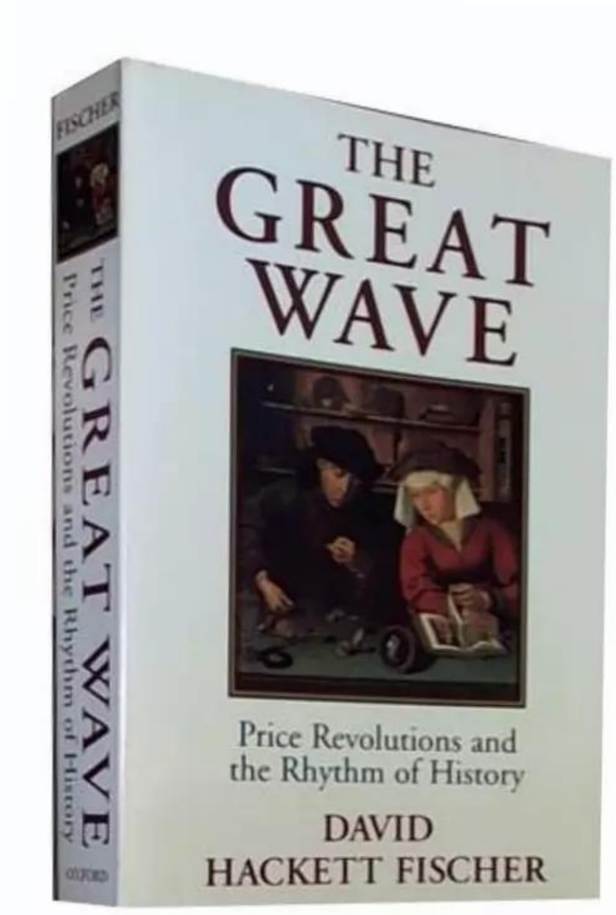
To understand ultra-long-term macroeconomic and technological driving forces that subtly shape many aspects of today's markets for stocks, bonds, real estate, and commodities, it is essential to study time-series data that go back as far as possible. Prof. Fischer explored ~1,000 years of data in "The Great Wave" (1996), Reinhart & Rogoff ("This time it's different", 2009) went back 800 years; Homer & Sylla ("History of interest rates" 4th edition, 2005) compiled and examined 4,000 years of interest rate data.

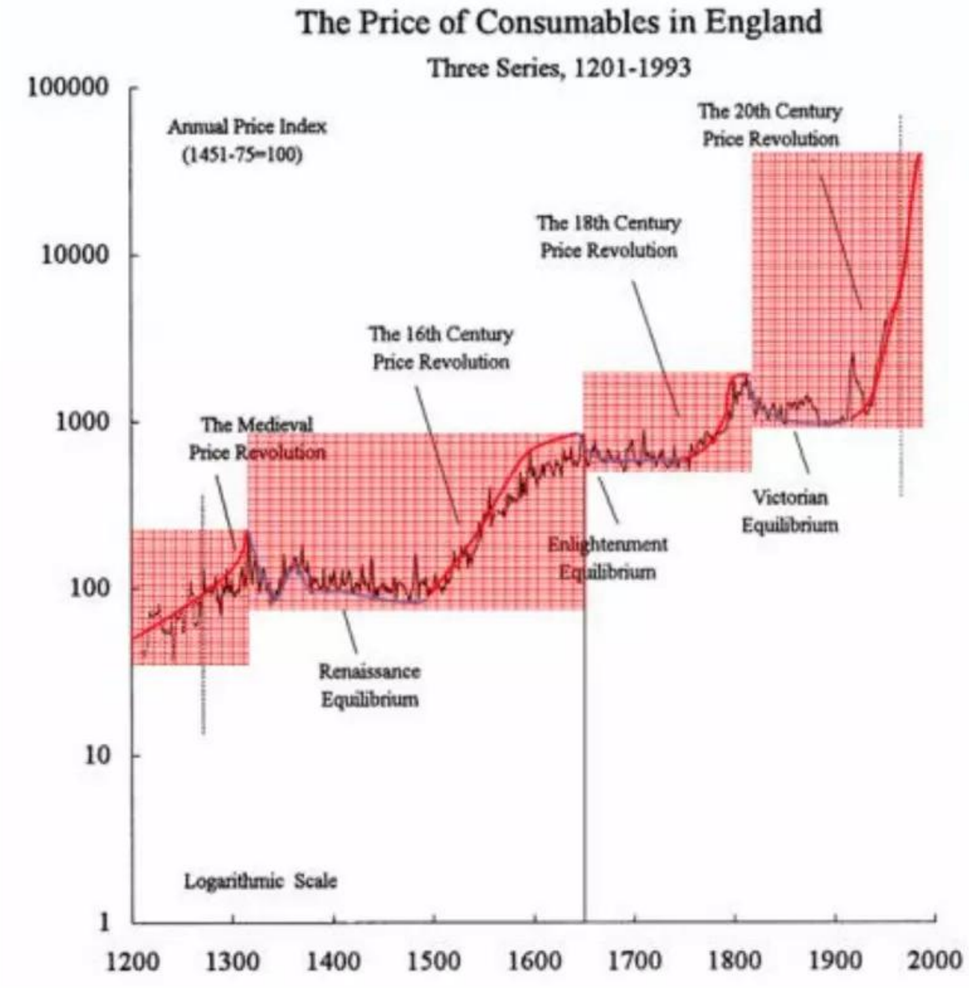
http://csmgeo.csm.jmu.edu/geollab/fichter/gs102/2008PowerPoints/29-GreatWave-GG102.pdf

"The Great Wave: Price Revolutions and the Rhythm of History“

David Hackett Fischer, Professor of History, Brandeis University
Oxford University Press (1996) paperback (2000) 536 pp.

“We found evidence of four price revolutions since the twelfth century: four very long waves of rising prices, punctuated by long periods of comparative price equilibrium. This is not a cyclical pattern. Price revolutions have no fixed and regular periodicity. Some were as short as eighty years; others as long as 180 years. They differed in duration, velocity, magnitude, and momentum.”





https://www.amazon.com/Great-Wave-Revolutions-Rhythm-History/dp/019512121X

Brief overview of David Fischer's Great Wave concept

Qualitative model can predict details of what happens inside wave stages

In his book, Fischer meticulously characterized and described key details of what he calls four global "Great Waves" that have occurred during the past ~1,000 years, beginning from High Middle Ages right up until today.

Overview of Fischer's conceptual model for a two-stage Great Wave:

- **1st stage is ~ non-inflationary and called a "period of equilibrium": it usually persists for 60 - 100 years; its average duration is ~ 85 years. This stage is economically and societally beneficent and is typically accompanied by substantial increases in real wages and improvement in standards of living, as well as declines in prices of manufactured goods, rents, and interest rates.**

- **2nd stage is inflationary and called a "price revolution": its total duration is usually longer and more variable length-wise than 1st stage. Unlike periods of equilibrium, price revolutions are quite pernicious and characteristically accompanied by progressively higher rates of inflation and interest on debt obligations. They finally crest and break in a terminal spasm that involves an inflationary economic cataclysm followed by a crash that creates an often-protracted deflationary episode. The final crash and deflation set the stage for beginning of the next Great Wave's low-inflation period of equilibrium.**

Technology innovation rates help drive periods of equilibrium

Increasing rates of population growth help drive Fischer price revolutions

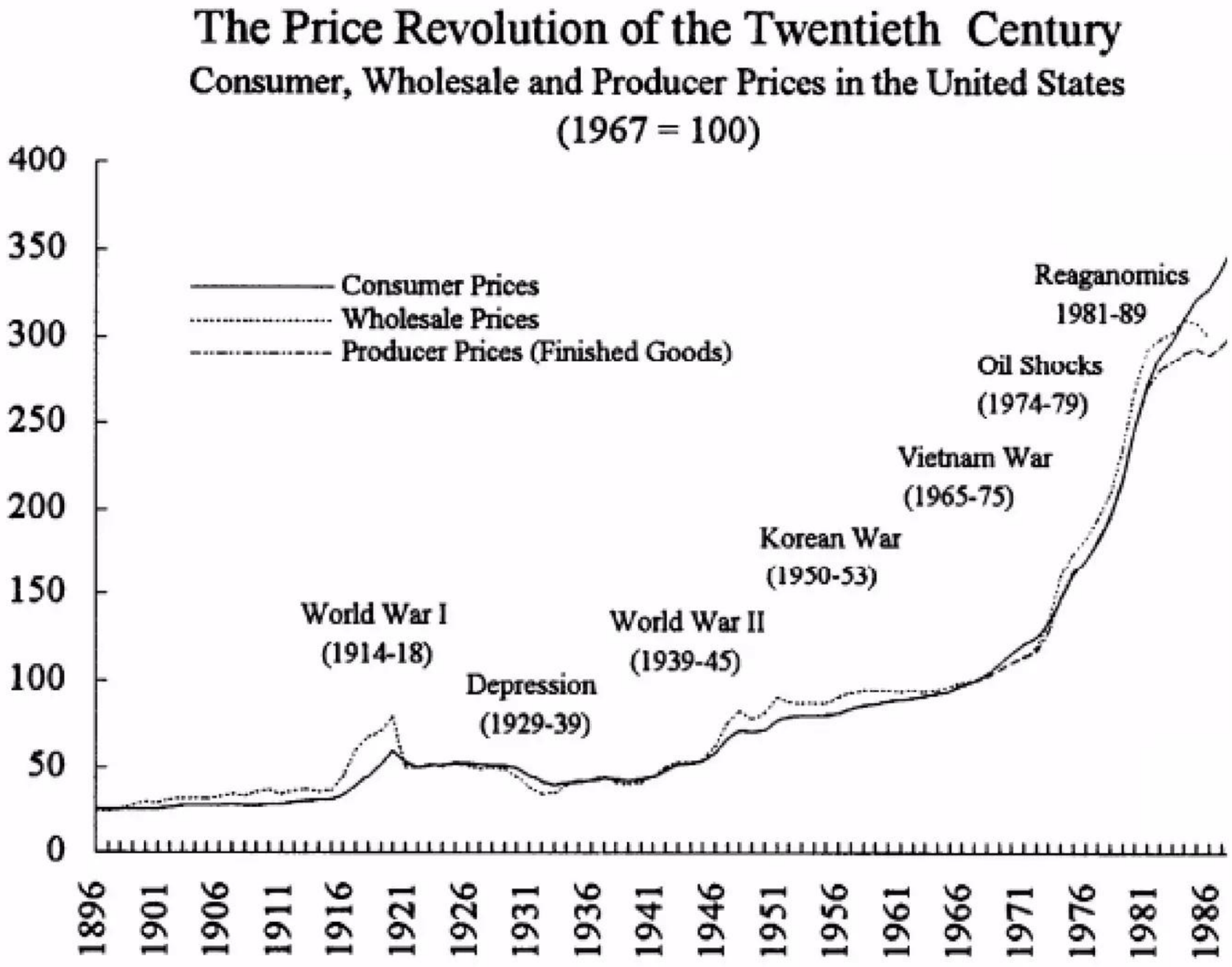
In 1997, Larsen helped elaborate Fischer's Great Wave model with his added hypothesis that innovation bursts and commercialization of new technologies are key driving forces that help create and maintain periods of equilibrium.

- For most of the last 1,000 years, as soon as advances in new technologies improved living conditions, ordinary people began feeling more optimistic about their futures and started having more children which in turn caused population growth rates to accelerate. Eventually, populations were increasing demand for goods and services at rates much faster than improvements in technology could reduce costs. Consequently, macroeconomic inflation rates tended to accelerate in parallel with ongoing increases in human population.

- Price inflation affects human psychology and economic behavior. Persistent inflation creates positive feedback loops in which consumers and businesses respond to perceived inflation by further accelerating their purchases of even more goods & services and hoarding. This rational behavioral response drives a nonlinear ratcheting process in which prices of goods and services ping-pong and accelerate upward, seemingly without end. Thus, higher near-term inflation causes even higher rates of future inflation, and so on. These self-reinforcing feedback loops are a key driving force in Fischer price revolutions that ultimately end with some type of very destructive cataclysm and deflation when over-stressed markets and banking systems finally spiral out-of-control.

20th century price revolution ended in late 1970s early ‘80s

Interest rate on 1-year U.S Treasury bills peaked at over 17% back in 1981



Adapted from chart by David H. Fischer

http://csmgeo.csm.jmu.edu/geollab/fichter/gs102/2008PowerPoints/29-GreatWave-GG102.pdf

Fischer & Larsen: new period of equilibrium began ~ 1979-80

Current period could go past 2065 if population growth rates slow greatly

Both Fischer and Larsen presently believe that a new 21st century low-inflation period of equilibrium probably began in approximately 1979 -1980.

- Fischer publicly reaffirmed this conclusion when he opined in his 1999 *Barron's* interview, "As much as I've always avoided prophecy, indications like falling crime rates and recent rises in real income seem to indicate that we may be on the cusp of yet another equilibrium period."
- Recent data strongly suggests that the world population growth rate appears to be slowing down and perhaps even flattening-out. If such apparent trends in this data are confirmed, the 21st century would be the first period of equilibrium in over 800 years during which world population growth was *decelerating* instead of accelerating. One could reasonably speculate that such a fortuitous development might have effect of helping to restrain that source of future inflationary pressure and thus prolonging the ultimate duration of this period of equilibrium beyond historical norms.
- If new Fischer period of equilibrium did begin in ~1979-80, it could have very important strategic consequences for science and technology, macroeconomics, business, and geopolitics over the next 30 - 50 years.
- 1999 *Barron's* article explores ideas surrounding Fischer's Great Waves

Barron's magazine article was published January 11, 1999

Value of DJIA at ~ 9,620 when Fischer's Great Wave ideas were discussed

BARRON'S

January 11, 1999

Are We Headed For a New Age?

Stable prices in the past have heralded prosperous and astounding eras

BY JONATHAN R. LAING – "Are we about to enter a decades-long period of rising purchasing power, mind-boggling technological breakthroughs and increasing social harmony? Numerous signs suggest that we are, much as the world did during the Industrial Revolution in the 1800s, the Renaissance in the 1400s and the Enlightenment in the 1700s."

Technology innovation bursts drive Periods of Equilibrium

Innovation boosts productivity which reduces prices and interest rates

January 1999 – selected quotes from *Barron's* article:

- **"Another explanation comes from Chicago-based … Lewis Larsen who graced … *Barron's* … a decade ago with a dead-on prediction that a coming technology revolution would vault the U.S. decisively ahead of the Japanese in international economic competitiveness. In Larsen's view, bursts in technological innovation, with all their attendant productivity gains, are the crucial factors these days in bringing on periods of price equilibrium."**

- **"He [Larsen] describes the process: Inflationary waves, particularly in their late virulent stages, force economic substitutions through technological change. But only when disinflation begins and interest rates come down can many of these ideas attract the financing necessary to achieve critical mass. Then, a self-reinforcing process sets in. Innovation brings down prices and interest rates, allowing more investment which, in turn, lowers cost and increases efficiency even more. And so on."**

- **"Larsen cites statistics on some 200 years of U.S. patents to bolster his argument."**

Patent issuance rates reflect rates of technology innovation

New technologies are impacting many different markets, including energy

January 1999 – selected quotes from *Barron's* article:

- **"Patent activity skyrocketed after 1820 to double the level of the first two decades of the century. Later on, that era of equilibrium benefited from quantum leaps in patent activity in the 1860s and again in the 1880s after the effects of the 1873 bank panic [and ghastly economic recession] wore off. And today, we're in the early stages of yet another burst in patent activity, according to Larsen, which augurs well for increased productivity gains. Last year, some 112,000 patents were granted, compared with 66,000 in 1981, when inflation was cresting." [U.S. Patent & Trade Office issued 303,051 patents in 2016]**
- **"On top of that, recent technological changes have played a major if unpublicized role in the collapse in crude oil prices, says Larsen. Among the key developments are recent advances in direct conversion of cheap natural gas into synthetic crude oil, plus use of embedded microprocessors to cut power used by electronic components and computers used in 'standby' mode by more than 95%. And this doesn't even take into account huge energy-saving breakthroughs that Larsen expects in … automobiles powered by hydrogen fuel cells and possible commercialization of power generation techniques such as cold fusion."**

Quotes from private Larsen memo dated August 10, 2011

Memo prompted by anomalies in price of Gold versus price of stocks

- "Based on … selected chart data, the S&P/Gold and Dow/Gold ratios look way out of whack. Today, based on history, prices of U.S. equities (proxy is S&P 500 index) are unusually inexpensive in comparison to the price of gold."
- "Gold is not presently expensive because of a soon-to-be rapid acceleration in overall rate of inflation. In my view, that scenario is very unlikely, especially given the reduction in government fiscal stimulus now starting in the U.S. and Europe. Recent behavior of U.S. Treasury securities supports that notion --- yields on the long-end of the debt markets (which Fed has very little direct control over) have actually gone down significantly since the latest market break began. As of mid-session this morning, the 30-year US Treasury bond was being priced to yield 3.53%; if a pending inflationary surge were the underlying factor spooking today's equity markets, long bond yields would be going up not down. Three-month T-bill rates are within a rounding-error of zero %; no hints of inflationary pressures there either. The fact is that the U.S. economy is still quite weak and there is little demand for short-term credit --- U.S. consumers aren't in good enough financial shape to help run-up hard asset prices and create inflationary pressures."
- "Today, the price of energy (its proxy being the real price of crude oil) is very expensive in historical terms."

https://www.slideshare.net/lewisglarsen/lattice-energy-llclarsen-memo-re-stock-indexes-vs-gold-price-ratiosaugust-10-2011/1

Quotes from private Larsen memo dated August 10, 2011

- **"Regarding the present investment climate: gold and crude oil are relatively expensive compared to other alternative types of investments; long- and short-term interest rates are relatively low by historical standards."**
- **"Real estate values have returned to more normal levels and are presently very illiquid in the U.S. and elsewhere. Current inflation rates are relatively low in the U.S. (-0.4% in 2009; +1.6% in 2010), Europe, and Japan; while stock price levels have corrected from interim highs in real terms (while not unusually low, stock P/E values are presently not unusually high either --- actually, somewhat 'average')."**
- **"Long-term secular uptrend in stock prices, amazingly, still appears to be intact. Although stock markets could easily go sideways in a choppy up-down pattern for another 1 – 2 years as the current global economic mess slowly sorts itself out, the most likely outcome in my opinion, again barring some sort of an economic depression, is a resumption of the long-term secular bull market in equities as we move somewhat further into the future past the present economic 'speed bumps'."**
- **"In conclusion: if I had to make a 5 - 10 year buy-and-hold portfolio decision today, the asset class most likely to outperform all others over that time horizon would still appear to be the US stock market."**

https://www.slideshare.net/lewisglarsen/lattice-energy-llclarsen-memo-re-stock-indexes-vs-gold-price-ratiosaugust-10-2011/1

Quotes from public Lattice PowerPoint dated July 4, 2013

Covers history, macroeconomics, LENRs, equities, and real price of gold

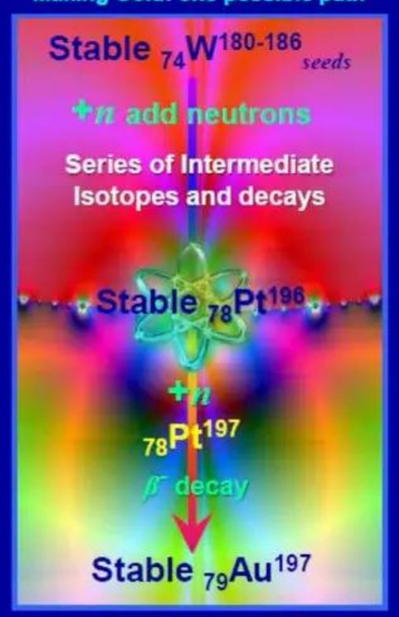
History, macroeconomics, LENRs, and the price of gold

Real gold price vs. prices of other asset classes

Supply, demand, and price: where do we go from here?

LENR transmutation processes could potentially increase supply in future

Example 1
Making Gold: one possible path



Neutron-catalyzed transmutations

Future possibilities

Lewis Larsen
President and CEO
Lattice Energy LLC

July 4, 2013

"All that is gold does not glitter,
Not all those who wander are lost;
The old that is strong does not wither,
Deep roots are not reached by the frost.

From the ashes a fire shall be woken,
A light from the shadows shall spring;
Renewed shall be blade that was broken,
The crownless again shall be king."

J.R.R. Tolkien, poem in "The Fellowship of the Ring" (1954)

Example 2
Making Gold: another possible path

Neutron-catalyzed transmutations

https://www.slideshare.net/lewisglarsen/lattice-energy-llc-historymacroeconomicslenrsand-real-price-of-goldjuly-4-2013

Quoted from Slide #55: Lattice PowerPoint dated July 4, 2013

Price of Gold could substantially underperform equities for 5 - 15 years

- "Ongoing explosion in new technologies and products continues to accelerate, as evidenced by vast volumes of patent filings; e.g., nanotechnology, robotics, amongst a huge multitude."
- "In the case of the price of gold, a period of equilibrium is not characterized by high rates of inflation and hyperinflations in fiat currencies of major countries."
- "If LENRs [ultralow energy neutron reactions] are commercialized in the near-future (which is likely), manmade gold could represent a new source of supply."
- "On the demand side, worldwide deceleration in rates of population growth, especially in China and India, are a negative factor. In such an environment, it's difficult to construct a bullish supply/demand scenario for gold."
- "Consequently, real price of gold likely to substantially underperform real appreciation in equities during most of next 5 - 15 years."

https://www.slideshare.net/lewisglarsen/lattice-energy-llc-historymacroeconomicslenrsand-real-price-of-goldjuly-4-2013

Quoted from Slide #55: Lattice PowerPoint dated July 4, 2013

Next leg of secular uptrend in stock market potentially extends to 2033

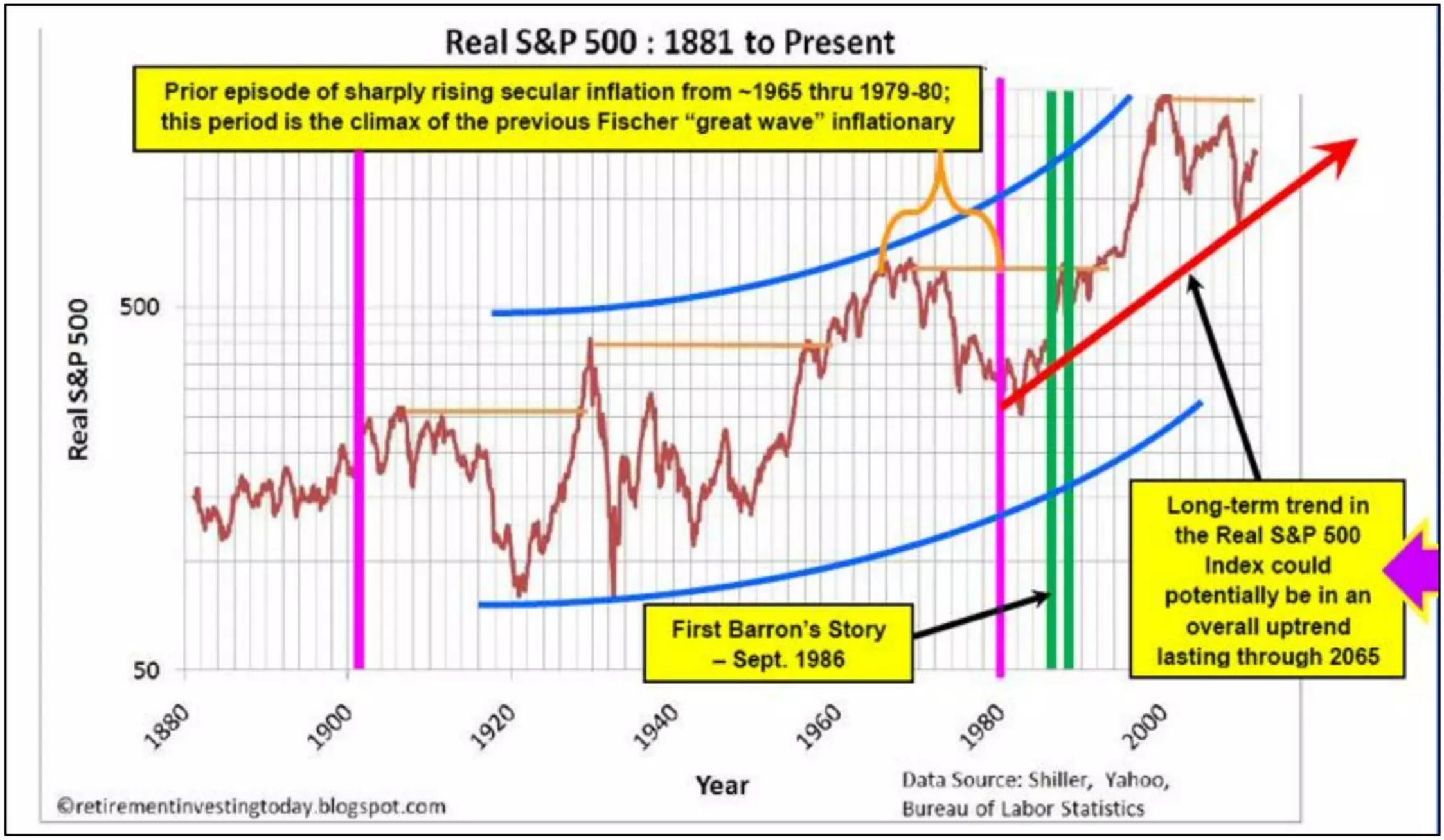
- "Retrospectively, DJIA/Gold ratio appears to have made an intermediate low back in August 2011; this nadir could end-up being unchallenged for a considerable time period - decades?"
- "If our speculative hypothesis that gold's torrid price run-up from 2008 - 2011 involved transient demand factors proves to be correct, and if we are living in a Fischer period of equilibrium, this ratio still has substantial upside potential over the next 5 - 15 years."
- "Independent of the gold price, the multi-decadal uptrend in real DJIA and S&P 500 indices appears to be intact; the US economy is finally crawling out of its near-depression and poised for reasonable rates of growth over the next 5+ years. If this scenario is realized, the secular bull market uptrend in stock prices (equities) will return with a vengeance, first in the US with Europe and many other countries' stock markets following thereafter. The last such run went from ~1980 to 2000 (20 years)."
- "It is possible that the next leg in the uptrend in equities could go from 2013 - 2033, which would still fall well-within the boundaries of the present Fischer period of equilibrium (which could potentially extend out to at least 2065)."

https://www.slideshare.net/lewisglarsen/lattice-energy-llc-historymacroeconomicslenrsand-real-price-of-goldjuly-4-2013

July 4, 2013 PowerPoint: screenshot of graph on Slide #35

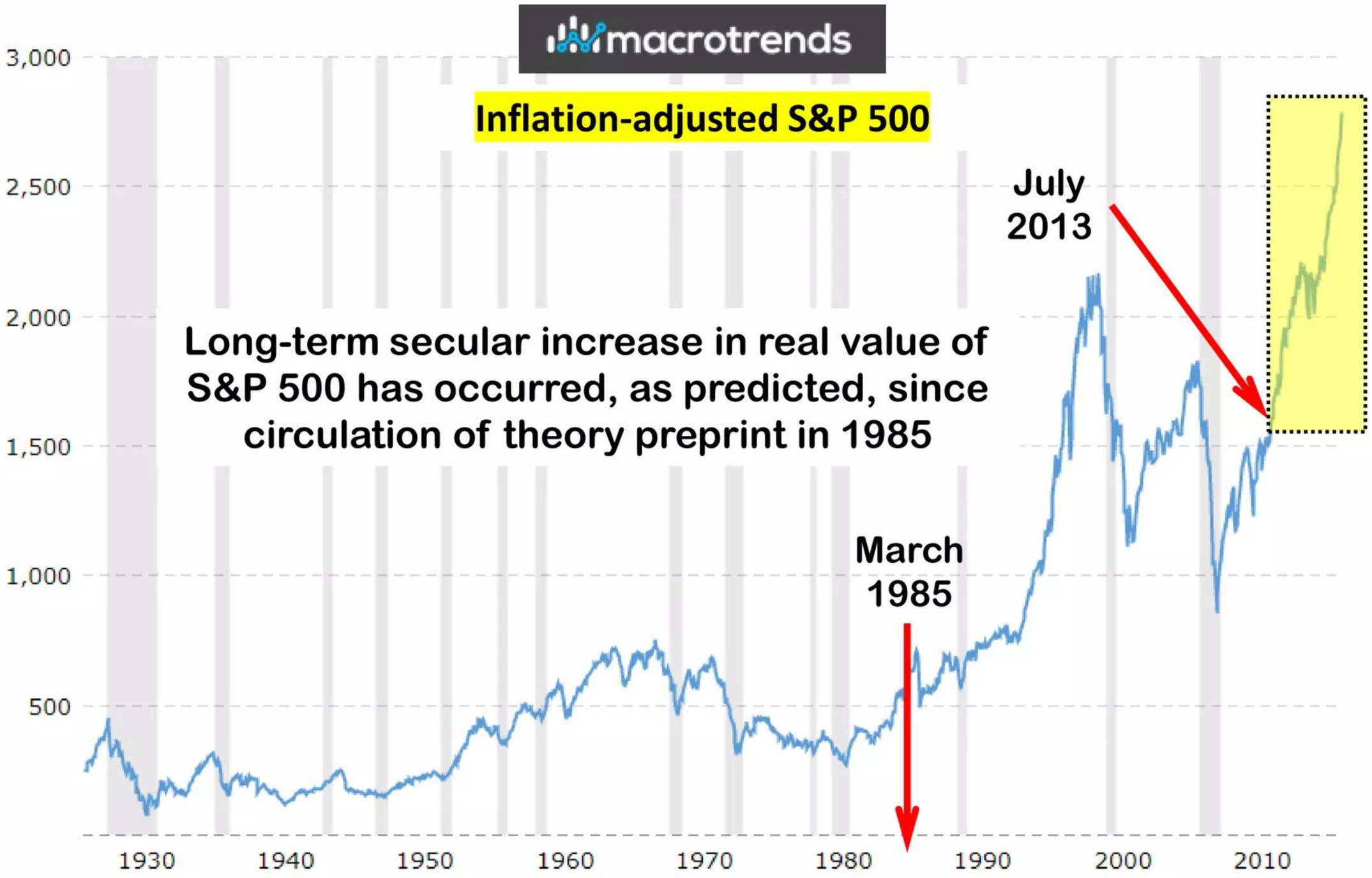
Major market correction from 2000 - 2013 didn't violate long-term uptrend

Blue curved lines show boundaries of hypothesized long-term nonlinear price uptrend



Real S&P 500 has reached new all-time highs since July 2013

Yellow-shaded box shows increase in S&P 500 since July 2013 forecast



Real price of Gold has changed little since July 2013 forecast

Current macroeconomic and inflation environment not bullish for Gold

Gold Prices - 100 Year Historical Chart

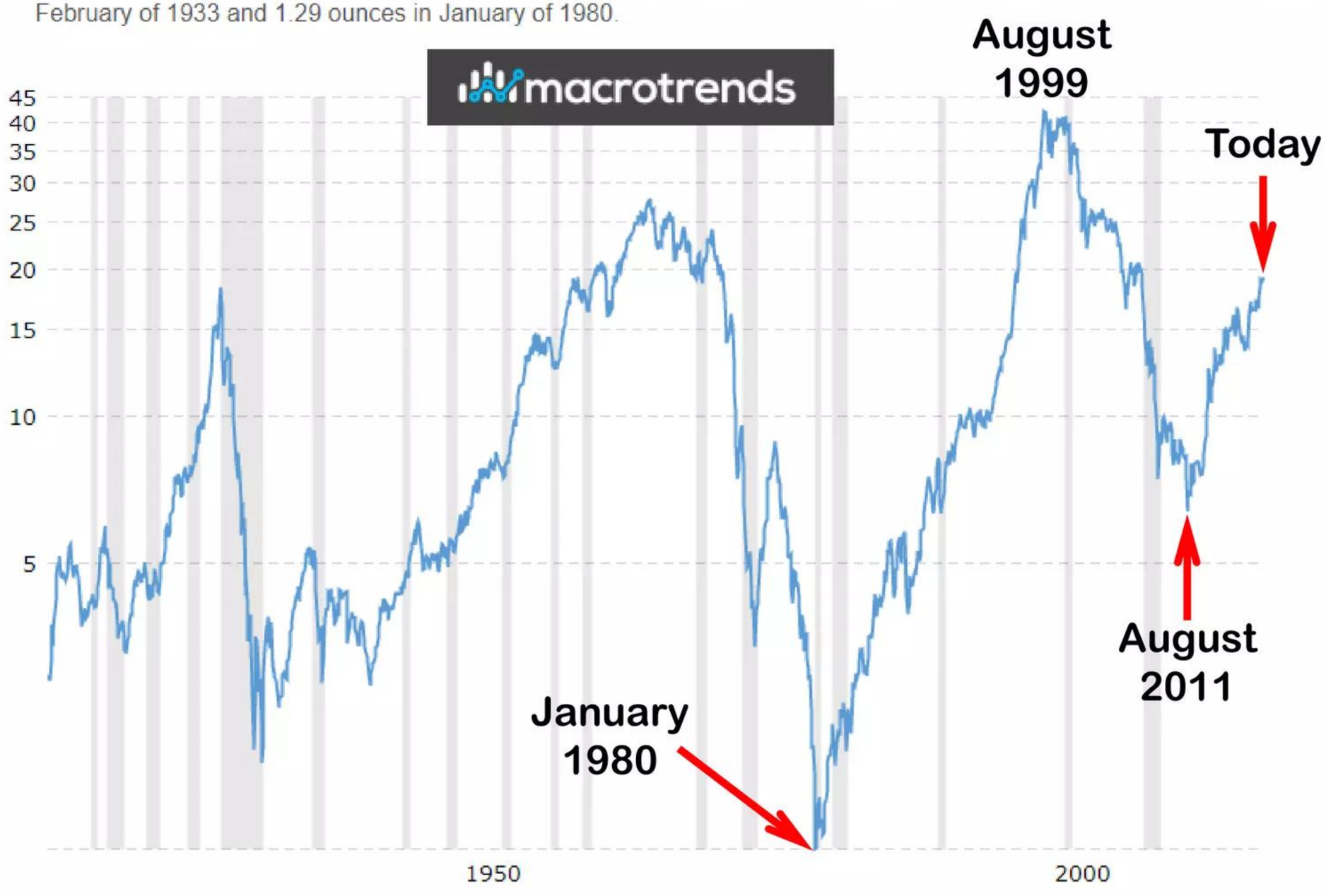
Interactive chart of historical data for real (inflation-adjusted) gold prices per ounce back to 1915. The series is deflated using the headline Consumer Price Index (CPI) with the most recent month as the base. The current month is updated on an hourly basis with today's latest value. The current price of gold as of January 15, 2018 is **$1,342.30** per ounce.

DJIA/Gold ratio has increased since August 2011 memo

Major market valuation correction in stocks lasted from ~ 2000 to 2013

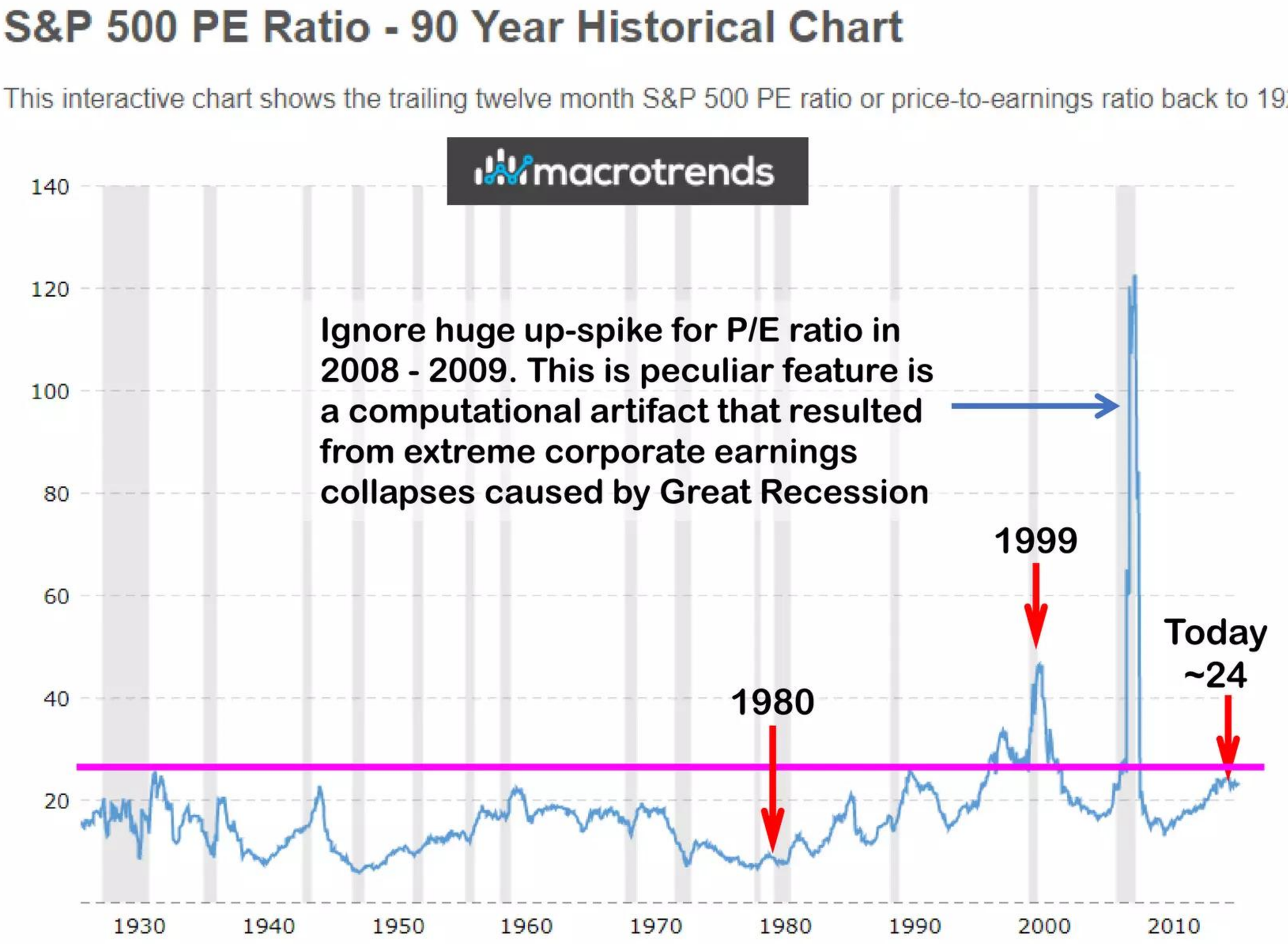
Dow to Gold Ratio - 100 Year Historical Chart

This interactive chart tracks the ratio of the Dow Jones Industrial Average to the price of gold. The number tells you how many ounces of gold it would take to buy the Dow on any given month. Previous cycle lows have been 1.94 ounces in February of 1933 and 1.29 ounces in January of 1980.



P/E ratios near high-end of trading range going back to 1926

24 P/E ratio well-below nosebleed mid-40s P/E at 1999 - 2001 market peak

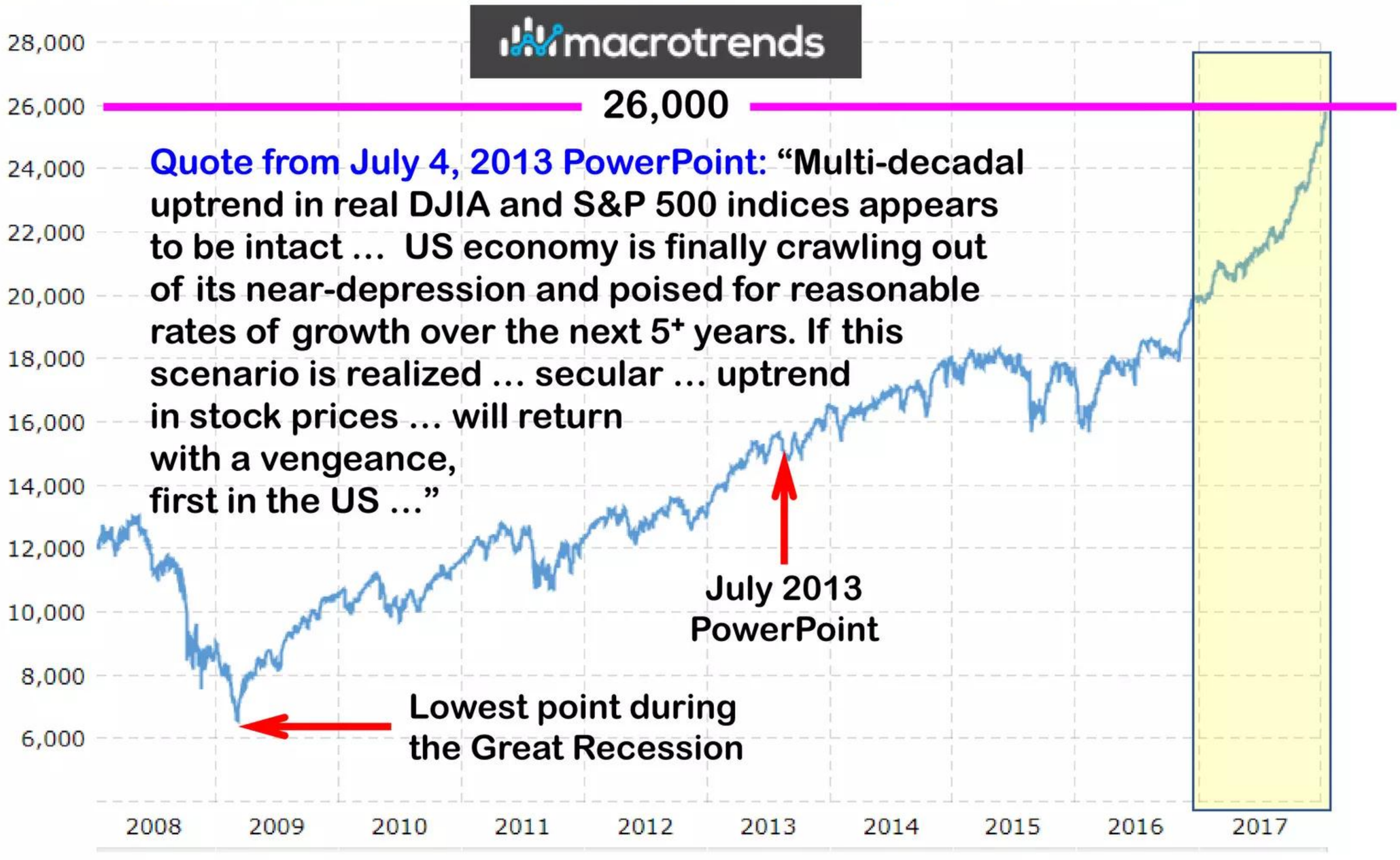


DJIA has risen by ~ 6,000 points (33%) since January 1, 2017

Rise was nearly uninterrupted; near-term technical correction is overdue

Dow Jones - 10 Year Daily Chart

Interactive daily chart illustrating the performance of the Dow Jones Industrial Average market index over the last ten years. The current price of the Dow Jones Industrial Average as of January 12, 2018 is **25,803.19**.



What's coming next?

BULL VS BEAR MARKET CHARACTERISTICS

Image credit:

Brief outline of what could happen in the near future

Key forces driving 30-year secular uptrend in stock prices still operating

Key long-term macroeconomic and technological forces that have driven 30-year secular uptrend in stock market prices and decline in both interest and inflation rates continue to operate as explained in Larsen qualitative models.

- Recent increase of ~6,000+ points (33%) in DJIA over past year occurred with limited price volatility and little retracement or any significant % technical corrections. Consequently, a healthy downward technical price correction in stock market indices is probably overdue after such a painless meteoric rise. Such a correction would typically entail a hard, freakish decline --- seemingly out of nowhere --- followed by choppy, sideways trading-range market for some period of time. Size of break would depend on exactly what triggered it. 66% retracement or 4,000 points ("Fibonacci" correction) is not impossible and would not violate parametric boundaries of long-term secular uptrend. At today's price levels, initiating new positions or adding to previous positions on strength is not prudent; buying during corrections would be a better strategy

- On Black Monday 1987, I was trading and advising clients and well-remember the terrifying, seemingly unending market slide on that day. Armed with theory and models, I was pretty sure that the market break was purely technical and triggered by unnecessary Fed tightening, so we bought stocks and got some amazing bargains. Markets recovered very quickly after that memorable event.

Brief outline of what could happen in the near future

Technology explosion continues: large gains in productivity will resume

- 2008 housing and financial market debacles and their still-lingering aftermath were enormously damaging to financial situations of U.S. households. Thus, large-scale shifts between financial and tangible assets in U.S. household investment portfolios will remain frozen, on-hold until real family incomes start increasing substantially for a broad swath of U.S. population. That income can only be provided by protracted U.S. GDP economic growth of 3% or more
- Patenting activity and new product development are exploding and continue to accelerate. Static since ~ 2008, growth in worker productivity will soon resume and reaccelerate once new capital investments in technology are made and solutions begin to bear fruit. In U.S. and other advanced economies, capital and technology are presently replacing human labor at highest rate since the First Industrial Revolution. For example, President of Jack in the Box restaurants announced they might replace human cashiers with computerized kiosks because of increase in minimum wage (*Business Insider*, Jan. 9, 2018)
- Resumption of strong increases in productivity will put a strong damper on wage-price inflation and further reduce costs of goods and services. This will create downward pressures on prices of manufactured products and help prevent overall inflation rates from increasing very much beyond today's levels. This will help keep short- and long-term interest rates in roughly steady-state at relatively low values; 30-year secular downtrend in those rates is over, for now

Brief outline of what could happen in the near future

LENRs are revolutionary radiationless, waste-free nuclear energy source

- Macroeconomic business cycles still exist, although magnitudes of their peaks and troughs are greatly diminished by widespread adoption of computerized just-in-time inventory management practices in developed economies. These cycles will create oscillations around continued secular uptrend in stock prices: recessions will cause temporary market corrections for duration of economic slowdowns.
- U.S. Federal Reserve presently appears to be hell-bent on more tightening to "fight inflation." This could trigger temporary market corrections, depending on how it is perceived by investors. In any case, its primary effect would be to flatten or invert the yield-curve. Fed actions will have minimal effects on long-term interest rates as long as ongoing CPI inflation rate continues to remain well below 3 - 5% threshold
- U.S. had already regained international competitiveness before Trump's very bold initiatives to slash burdensome regulations and cut corporate tax rates. Those new actions further boosted U.S. economic prospects: 4 - 6% GDP growth now possible
- Ideas in *Barron's* articles (1986, 1988) foreshadowed some thinking in books by Rifkin ("The Third Industrial Revolution" 2011) and Schwab ("The Fourth Industrial Revolution" 2016). We agree distributed renewable energy sources like wind and solar should be broadly deployed to supplant fossil fuels as they are depleted and help mitigate global warming. However, intrinsic energy densities of renewables are vastly lower; they cannot 100% replace all fossil and nuclear energy sources.

LENRs: cutting energy's Gordian Knot

"Energy, broadly defined, has become the most important geostrategic and geoeconomic challenge of our time."

Thomas Friedman
New York Times, April 28, 2006

Creating New Age of energy

"**The Gordian Knot:** is a legend of Phrygian Gordium associated with Alexander the Great. It is often used as a metaphor for an intractable problem (disentangling an 'impossible' knot) solved easily by finding a loophole or thinking creatively ('cutting the Gordian knot')" - Wikipedia

Lattice, Mitsubishi Heavy Industries, Toyota, and Nissan are all working on new type of nuclear power generation technology that could be much better than fission or fusion because it would be hard-radiation-free and produce negligible long-lived radioactive wastes. While still in very early stage of commercial development, ultralow energy neutron reactions (LENRs) offer great promise as a new future source of affordable CO_2-free green energy.

New Age of energy

Revolutionary ultralow energy neutron reactions (LENRs)

Radiation-free LENRs transmute stable elements to other stable elements

Fission and fusion

Evolution of nuclear technology

Safe green LENRs

Laura 13

No deadly MeV-energy gamma radiation

No dangerous energetic neutron radiation

Insignificant production of radioactive waste

Vastly higher energies vs. chemical processes

Revolutionary, no CO_2 , and environmentally green

Is fully explained by physics of Widom-Larsen theory

Image credit: co-author Domenico Pacifici
From: "Nanoscale plasmonic interferometers for multispectral, high-throughput biochemical sensing"
J. Feng et al., *Nano Letters* pp. 602 - 609 (2012)

Key conclusions of theoretical paper published in Pramana

Journal is peer-reviewed publication of Indian Academy of Sciences

"A primer for electro-weak induced low energy nuclear reactions"
Y. Srivastava, A. Widom, and L. Larsen in *Pramana* (2010)

"The analysis presented in this paper leads us to conclude that realistic possibilities exist for designing LENR devices capable of producing 'green energy', that is, production of excess heat at low cost without lethal nuclear waste, dangerous γ-rays or unwanted neutrons. The necessary tools and the essential theoretical know-how to manufacture such devices appear to be well within the reach of the technology available now. Vigorous efforts must now be made to develop such devices whose functionality requires all three interactions of the Standard Model acting in concert."

Publications about LENRs and the Widom-Larsen theory

"Ultra low momentum neutron catalyzed nuclear reactions on metallic hydride surfaces"
A. Widom and L. Larsen (author's copy)
European Physical Journal C - Particles and Fields 46 pp. 107 - 112 (2006)
http://www.slideshare.net/lewisglarsen/widom-and-larsen-ulm-neutron-catalyzed-lenrs-on-metallic-hydride-surfacesepjc-march-2006

"A primer for electro-weak induced low energy nuclear reactions"
Y. Srivastava, A. Widom, and L. Larsen (author's copy)
Pramana - Journal of Physics 75 pp. 617 - 637 (March 2010)
http://www.slideshare.net/lewisglarsen/srivastava-widom-and-larsenprimer-for-electroweak-induced-low-energy-nuclear-reactionspramana-oct-2010

"LENR technology's compelling value proposition for oil & gas companies"
Aromatics in oil convert to CO_2-free LENR fuels w. 5,000x > heat vs. gasoline
L. Larsen, Lattice Energy LLC, April 12, 2017 [48 slides - download enabled]
https://www.slideshare.net/lewisglarsen/lattice-energy-llc-lenr-technologys-compelling-value-proposition-for-oil-and-gas-companies-april-12-2017

"Hacking the Atom" (Volume 1 - 484 pages) popular science book
Steven B. Krivit, Pacific Oaks Press, San Rafael, CA, September 11, 2016
Paperback US$16.00; hardcover US$48.00; Kindle US$3.99
https://www.amazon.com/dp/0996886451

New Age of democratized access to low-cost, CO_2-free LENR energy could enable high rates of sustainable global economic growth and create universal prosperity

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Image credit: "Jungle Outpost" by Jose Arias on DeviantArt