
The Makridakis Open Forecasting Center (MOFC)
Advancing the Theory and Practice of Forecasting
THE M COMPETITIONS
THE M CONFERENCES
THE M PUBLICATIONS
THE M COURSES
UNIVERSITY of NICOSIA

Applied Forecasting Course: Session 1

- Increasing the Utilization of Forecasting in Organizations
- Disclosing the "mystery" of forecasting
- The two equally important forecasting task

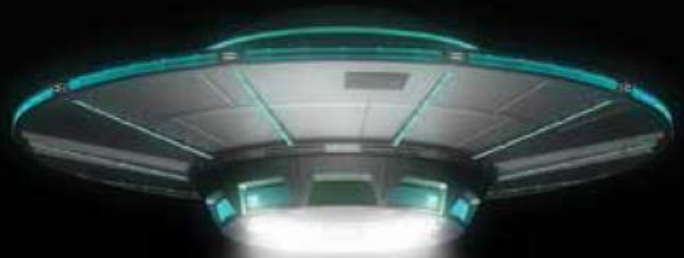
  (a) Accurate Predictions (b)Estimating Uncertainty
- Decomposition Methods
- Judgmental Versus Statistical/ML Forecast models
- Forecasting and Uncertainty
- Demonstrating R with examples

Professor Spyros Makridakis,
Director, Institute For the Future (IFF)
and the MOFC, University of Nicosia

FORESIGHT

Fall 2020 Issue 59

THE INTERNATIONAL JOURNAL OF APPLIED FORECASTING



The Benefits of Systematic Forecasting for Organizations: The UFO Project

Spyros Makridakis, Ellen Bonnell, Simon Clarke, Robert Fildes, Mike Gilliland, Jim Hoover and Len Tashman

INTRODUCTION

The purpose of this paper is to provide a realistic assessment of the potential benefits to organizations from applying systematic forecasting methods, particularly with respect to operational and tactical forecasting problems. Our overall goal is to improve the usage of forecasting in organizations (UFO) while incentivizing the adoption of systematic forecasting in organizations now employing only ad hoc methods.

We define *systematic forecasting* as the use of appropriate quantitative methods when suitable data are available, while allowing for judgmental inputs and adjustments that are supported by a documented and defensible rationale. Where little or no data are available, such as with new products, our definition encompasses structured management judgment including use of intention surveys, decision aids, Delphi procedures and others.

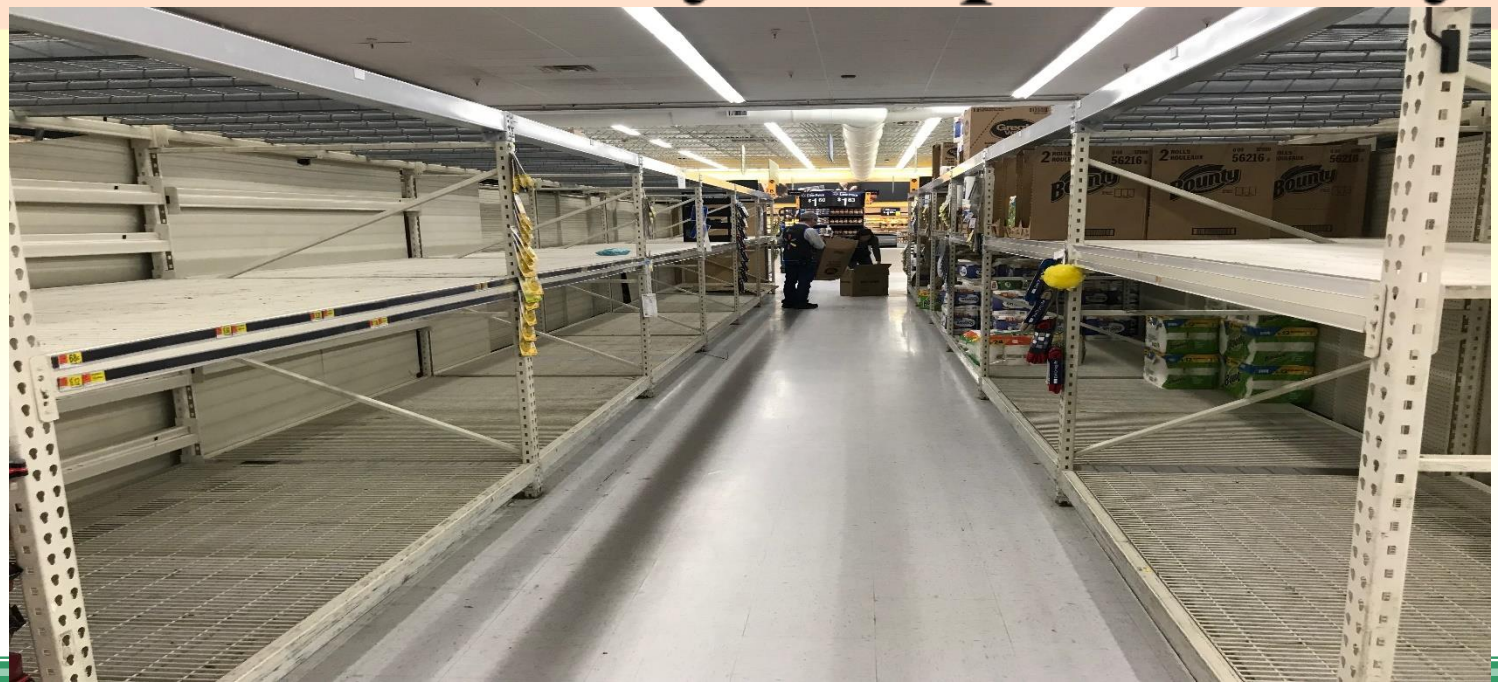
The genesis of the UFO project lies in a series of discussions within a group of practitioners and academics about the challenges facing the forecasting field and the need to learn why many organizations do not exploit advances in forecasting knowledge and technology.

Forecasting: Extrapolating past patterns/relationships

Forecasting is not crystal-ball gazing. Forecasting methods, from the simplest to the most sophisticated, do not possess prophetic powers. Their predictions are based on identifying and estimating past patterns and/or relationships that are then extrapolated to forecast the future.

The total forecasting failure, proving its great success!!!

The great toilet paper scarcity: March 12, 2020, US toilet paper sales ballooned 734% compared with the same day the previous year



The uncertainty around the forecasts must be clearly stated and its risk implications considered

All forecasts come with an error. All forecasts are uncertain with the only certainty being the existence of uncertainty.

There are two types of uncertainty: Normal and Fat-tailed like the toilet paper scarcity

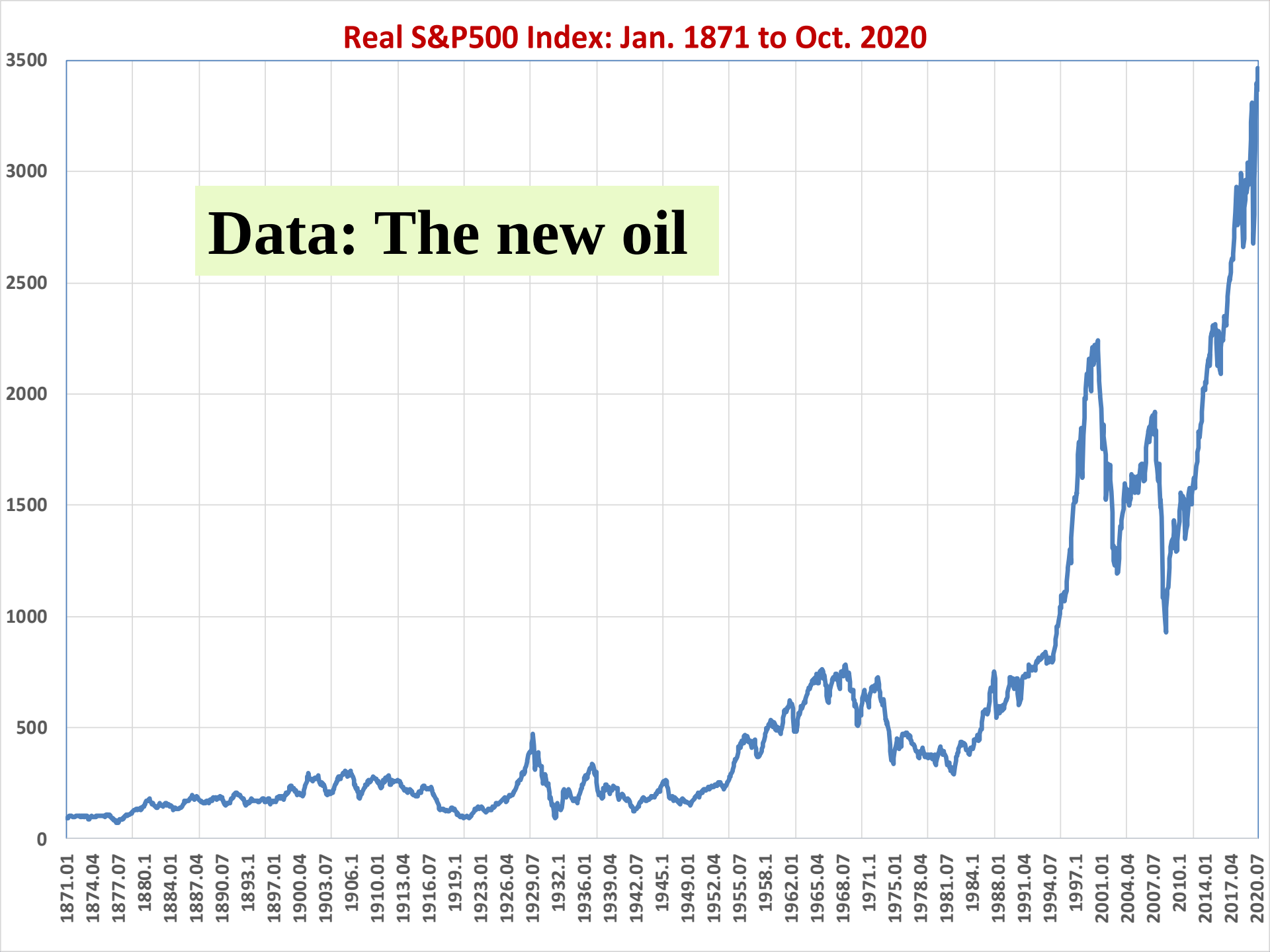
The objectivity of systematic forecasting Vs the optimism and wishful thinking of human judgment

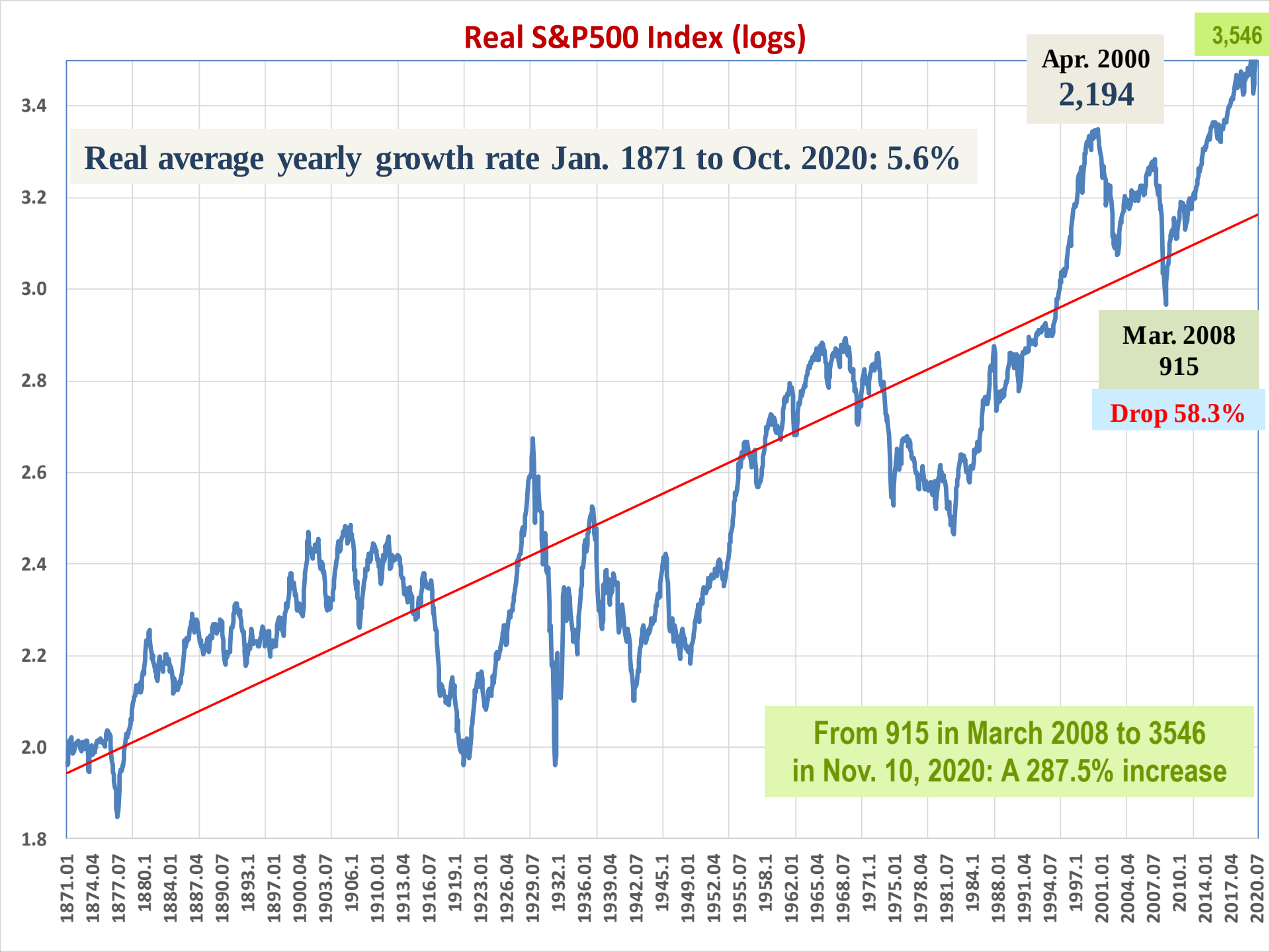
The most important advantage of systematic forecasting is its objectivity. It seeks to (a) identify past patterns and relationships to predict the future in a mathematically optimal manner, and (b) base estimates of the uncertainty in the forecasts on the volatility (variance) in the observed patterns/relationships.

What is the difference between systematic Forecasting and Fortune telling?

Systematic Forecasting always comes with an estimate of Uncertainty

The correct estimation of uncertainty is often more important than accurate predictions


Real S&P500 Index: Jan. 1871 to Oct. 2020
Data: The new oil
3500
3000
2500
2000
1500
1000
500
0
1871.01
1874.04
1877.07
1880.1
1884.01
1887.04
1890.07
1893.1
1897.01
1900.04
1903.07
1906.1
1910.01
1913.04
1916.07
1919.1
1923.01
1926.04
1929.07
1932.1
1936.01
1939.04
1942.07
1945.1
1949.01
1952.04
1955.07
1958.1
1962.01
1965.04
1968.07
1971.1
1975.01
1978.04
1981.07
1984.1
1988.01
1991.04
1994.07
1997.1
2001.01
2004.04
2007.07
2010.1
2014.01
2017.04
2020.07


Real S&P500 Index (logs)
3,546
Apr. 2000
2,194
Real average yearly growth rate Jan. 1871 to Oct. 2020: 5.6%
Mar. 2008
915
Drop 58.3%
From 915 in March 2008 to 3546
in Nov. 10, 2020: A 287.5% increase
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1871.01
1874.04
1877.07
1880.1
1884.01
1887.04
1890.07
1893.1
1897.01
1900.04
1903.07
1906.1
1910.01
1913.04
1916.07
1919.1
1923.01
1926.04
1929.07
1932.1
1936.01
1939.04
1942.07
1945.1
1949.01
1952.04
1955.07
1958.1
1962.01
1965.04
1968.07
1971.1
1975.01
1978.04
1981.07
1984.1
1988.01
1991.04
1994.07
1997.1
2001.01
2004.04
2007.07
2010.1
2014.01
2017.04
2020.07

Stock Market: An amazing long-term stability coupled with huge uncertainty

Assuming a 58.3% drop like the 2000-2008
$100,000 will shrink to $41,700

Assuming an increase like the 2008-2020
$100,000 will grow to $287,541

Biggest one day drop: -22.6% on Oct 19, 1987

Biggest one day increase: +16.6 on Mar 15, 1933

Predicting stock market fluctuations: Day-to-day, month-to-month, year-to-year and long-term

The most profitable stock market forecasting approach: The use of a random number generator

Active fund managers trail the S&P 500 for the ninth year in a row in triumph for indexing

PUBLISHED FRI, MAR 15 2019 • 7:09 AM EDT | UPDATED FRI, MAR 15 2019 • 12:52 PM EDT

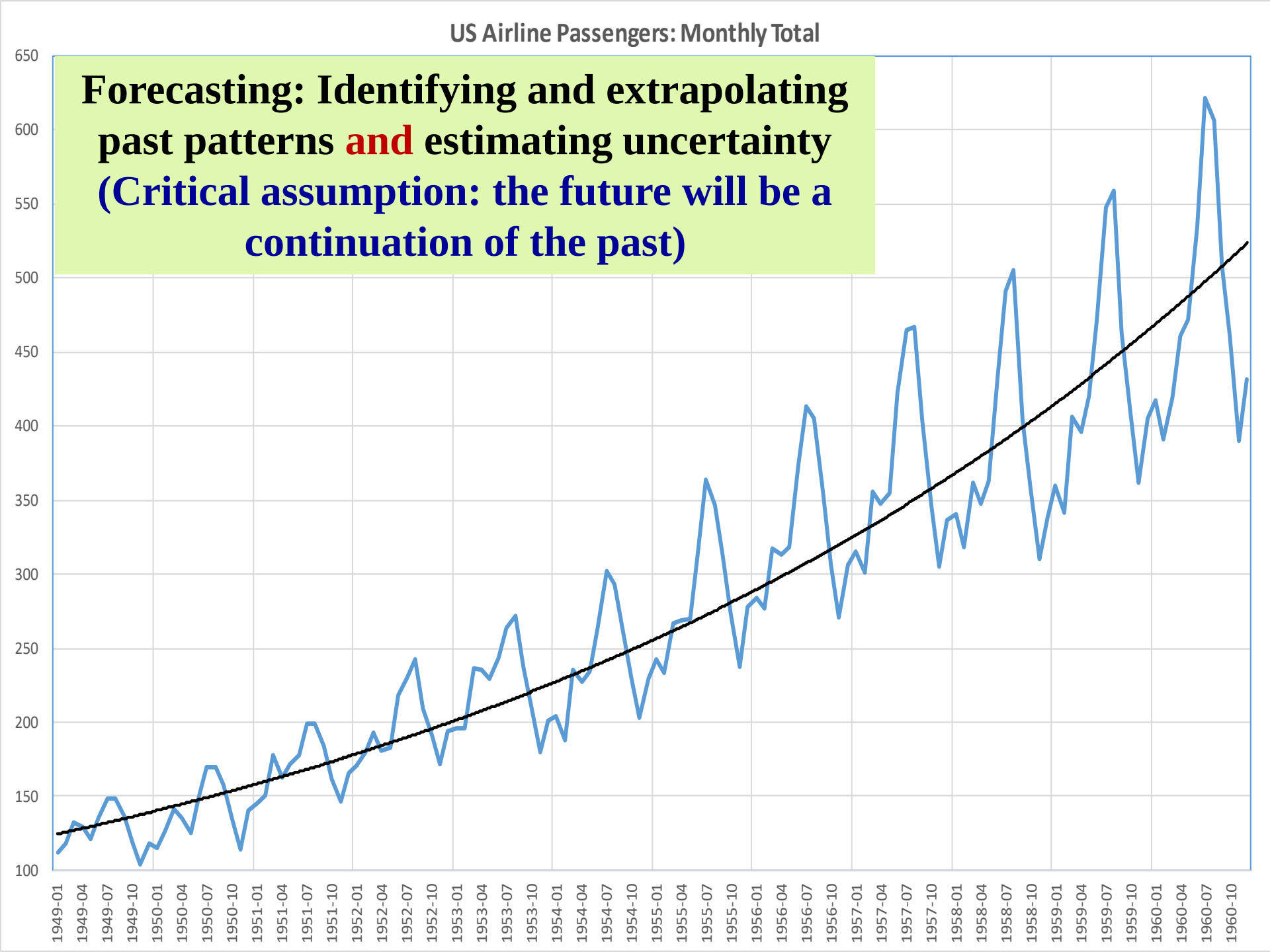
Bob Pisani
@BOBPISANI

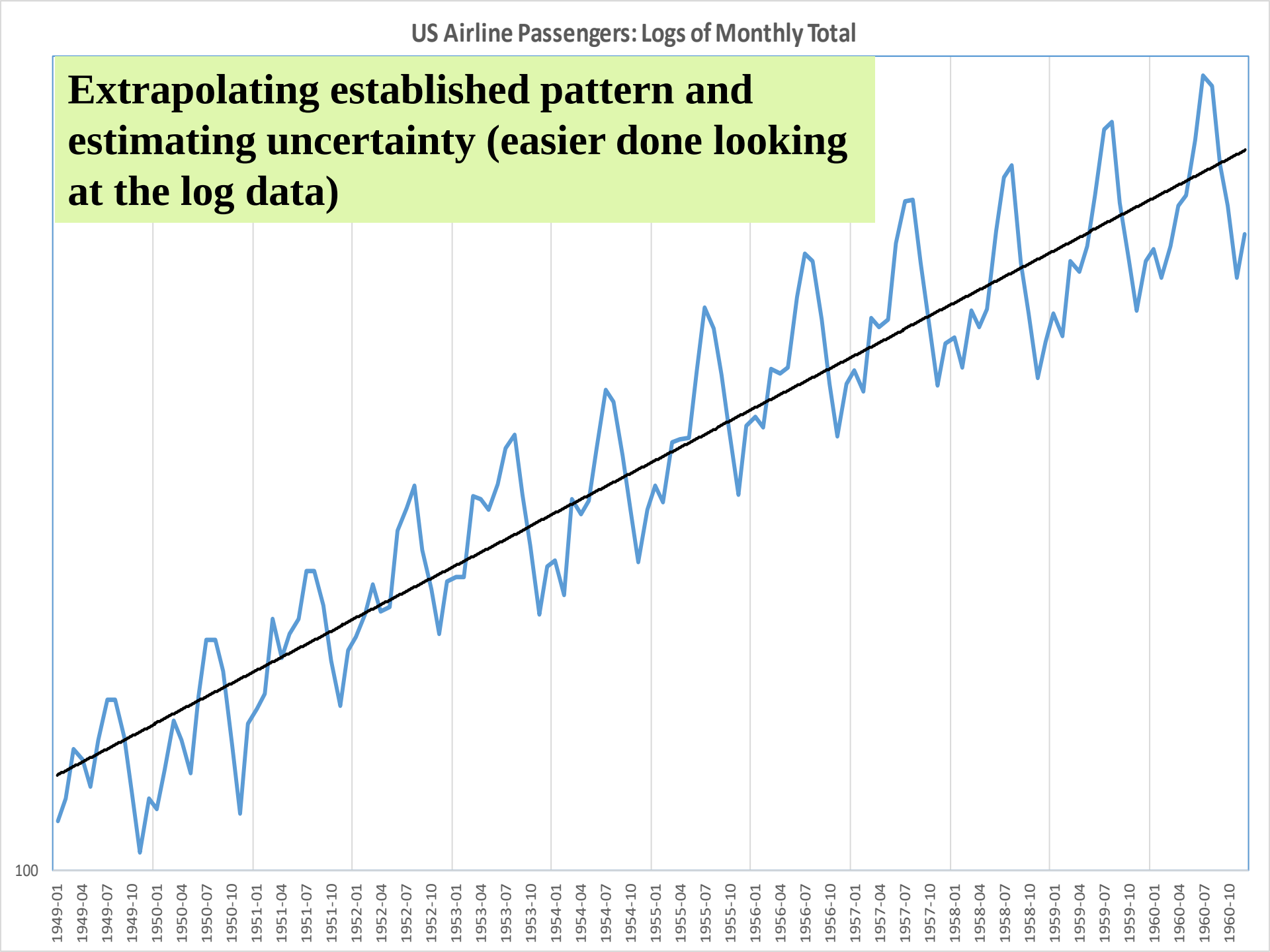
Value of Benchmarks

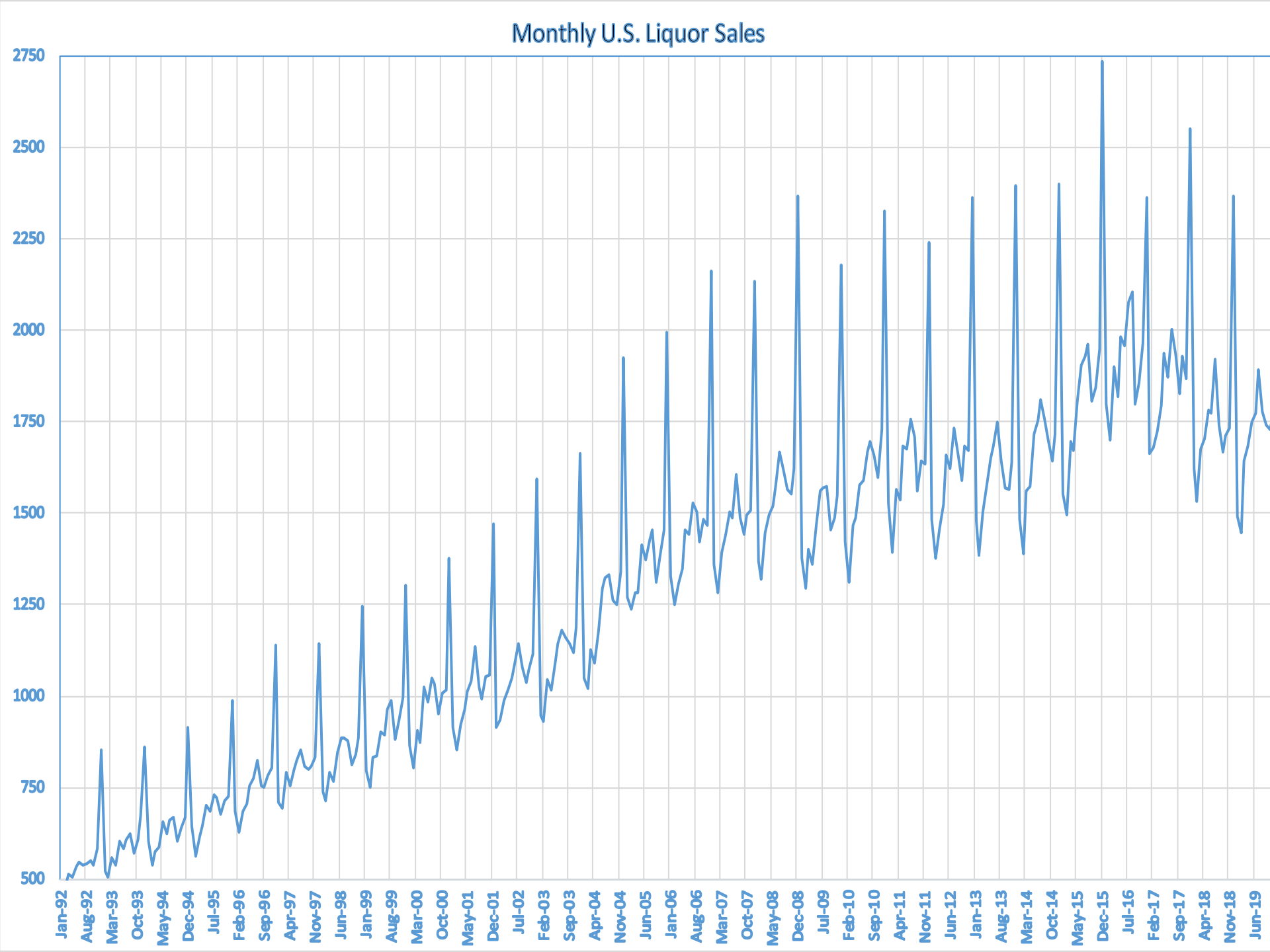
KEY POINTS

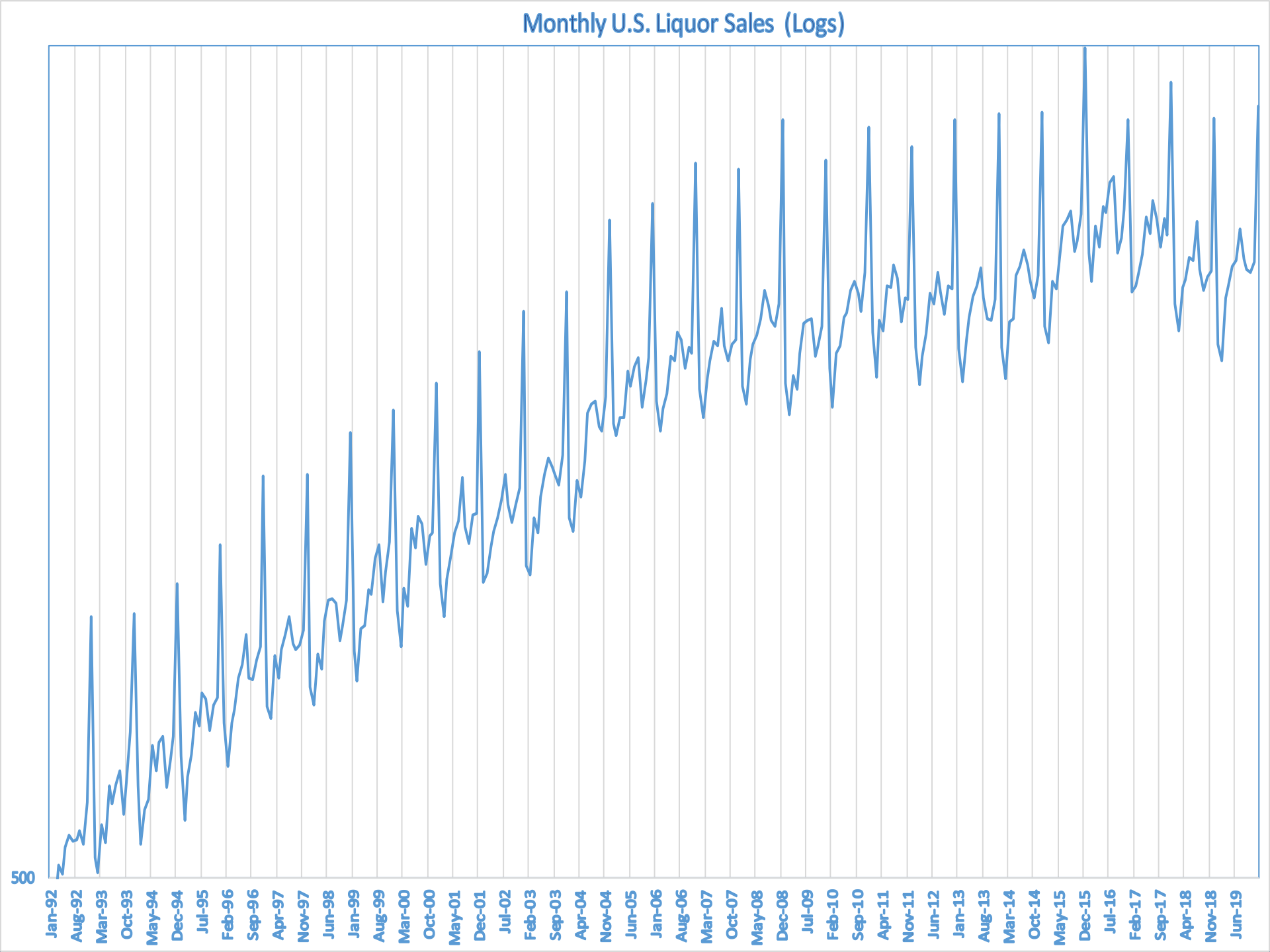
- Active managers who claim that they would do better during periods of heightened volatility are going to have to find another argument.
- For the ninth consecutive year, the majority (64.49 percent) of large-cap funds lagged the S&P 500 last year.
- After 10 years, 85 percent of large cap funds underperformed the S&P 500, and after 15 years, nearly 92 percent are trailing the index.

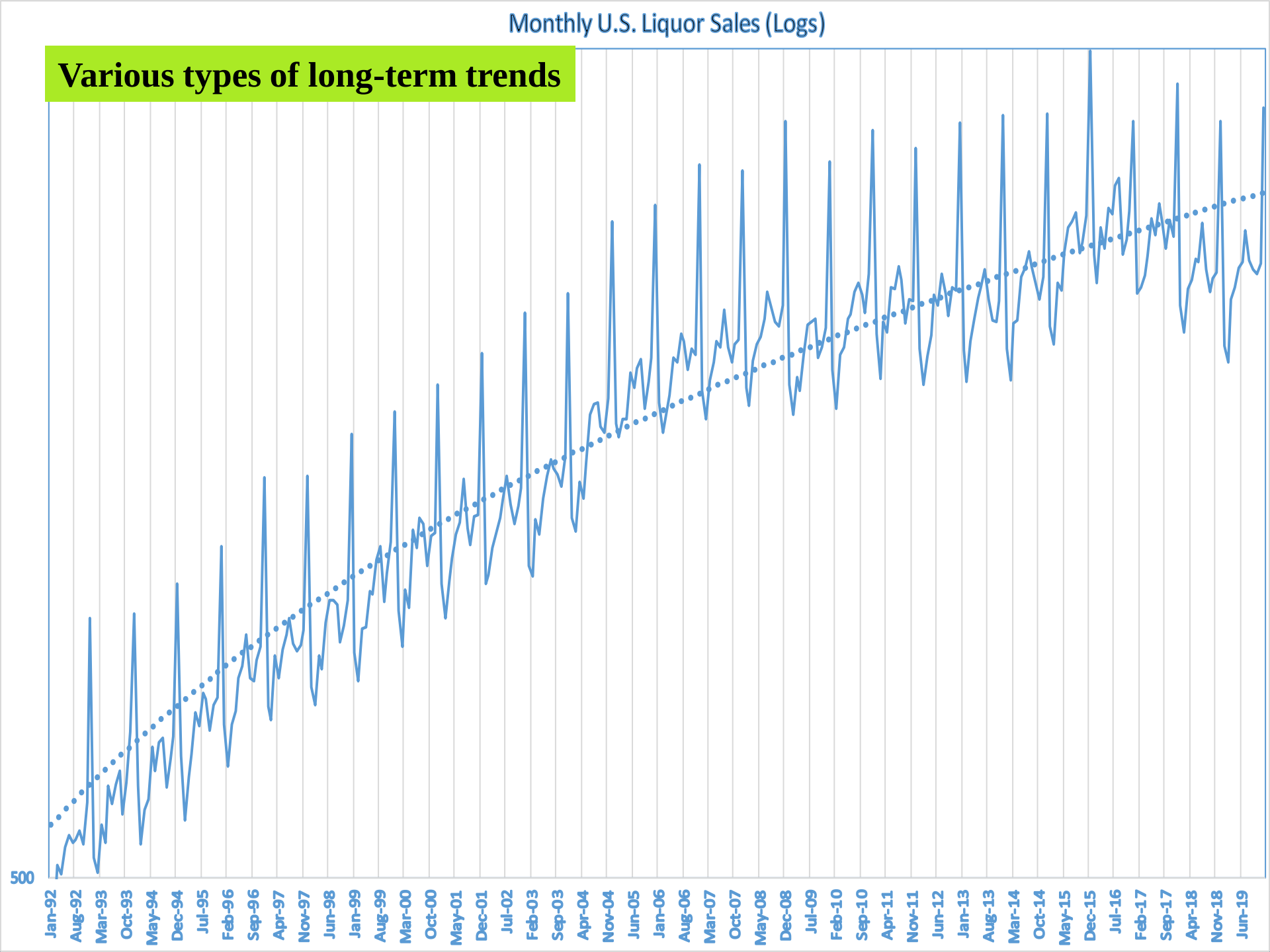
Extrapolating Patterns

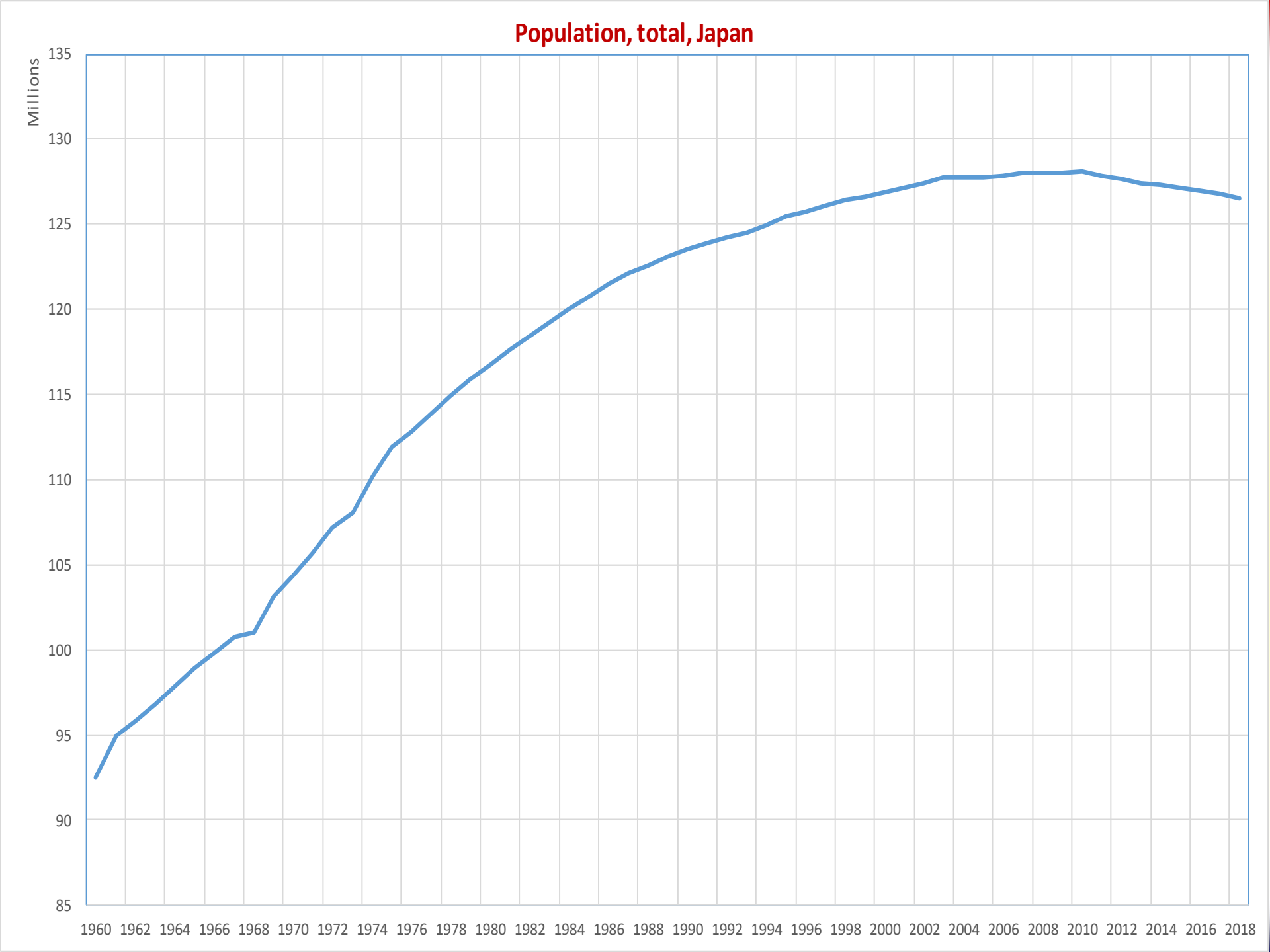

US Airline Passengers: Monthly Total
Forecasting: Identifying and extrapolating past patterns and estimating uncertainty (Critical assumption: the future will be a continuation of the past)
650
600
550
500
450
400
350
300
250
200
150
100
1949-01
1949-04
1949-07
1949-10
1950-01
1950-04
1950-07
1950-10
1951-01
1951-04
1951-07
1951-10
1952-01
1952-04
1952-07
1952-10
1953-01
1953-04
1953-07
1953-10
1954-01
1954-04
1954-07
1954-10
1955-01
1955-04
1955-07
1955-10
1956-01
1956-04
1956-07
1956-10
1957-01
1957-04
1957-07
1957-10
1958-01
1958-04
1958-07
1958-10
1959-01
1959-04
1959-07
1959-10
1960-01
1960-04
1960-07
1960-10

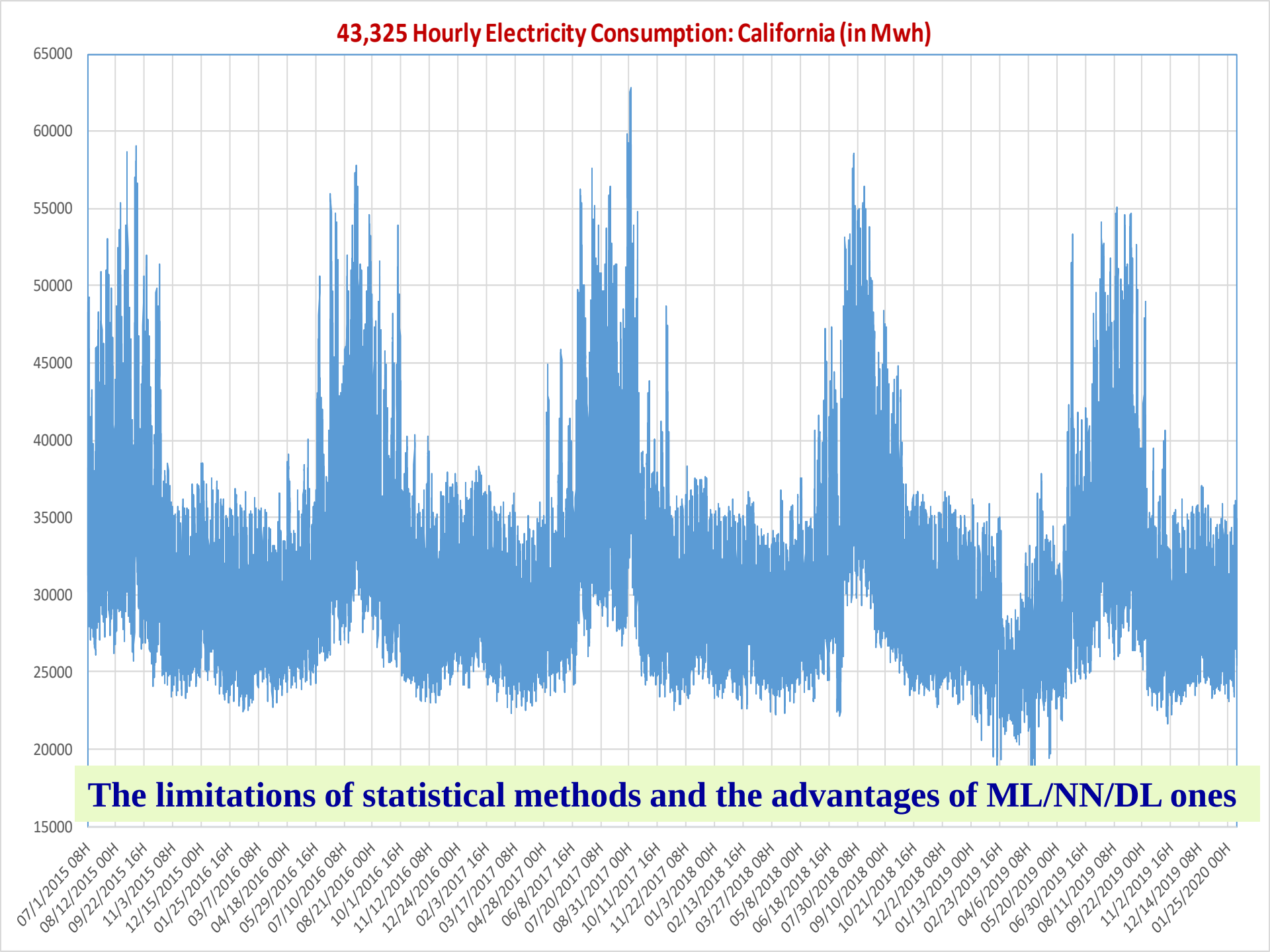

US Airline Passengers: Logs of Monthly Total
Extrapolating established pattern and estimating uncertainty (easier done looking at the log data)
100
1949-01
1949-04
1949-07
1949-10
1950-01
1950-04
1950-07
1950-10
1951-01
1951-04
1951-07
1951-10
1952-01
1952-04
1952-07
1952-10
1953-01
1953-04
1953-07
1953-10
1954-01
1954-04
1954-07
1954-10
1955-01
1955-04
1955-07
1955-10
1956-01
1956-04
1956-07
1956-10
1957-01
1957-04
1957-07
1957-10
1958-01
1958-04
1958-07
1958-10
1959-01
1959-04
1959-07
1959-10
1960-01
1960-04
1960-07
1960-10


Monthly U.S. Liquor Sales
2750
2500
2250
2000
1750
1500
1250
1000
750
500
Jan-92
Aug-92
Mar-93
Oct-93
May-94
Dec-94
Jul-95
Feb-96
Sep-96
Apr-97
Nov-97
Jun-98
Jan-99
Aug-99
Mar-00
Oct-00
May-01
Dec-01
Jul-02
Feb-03
Sep-03
Apr-04
Nov-04
Jun-05
Jan-06
Aug-06
Mar-07
Oct-07
May-08
Dec-08
Jul-09
Feb-10
Sep-10
Apr-11
Nov-11
Jun-12
Jan-13
Aug-13
Mar-14
Oct-14
May-15
Dec-15
Jul-16
Feb-17
Sep-17
Apr-18
Nov-18
Jun-19


Monthly U.S. Liquor Sales (Logs)
500
Jan-92
Aug-92
Mar-93
Oct-93
May-94
Dec-94
Jul-95
Feb-96
Sep-96
Apr-97
Nov-97
Jun-98
Jan-99
Aug-99
Mar-00
Oct-00
May-01
Dec-01
Jul-02
Feb-03
Sep-03
Apr-04
Nov-04
Jun-05
Jan-06
Aug-06
Mar-07
Oct-07
May-08
Dec-08
Jul-09
Feb-10
Sep-10
Apr-11
Nov-11
Jun-12
Jan-13
Aug-13
Mar-14
Oct-14
May-15
Dec-15
Jul-16
Feb-17
Sep-17
Apr-18
Nov-18
Jun-19

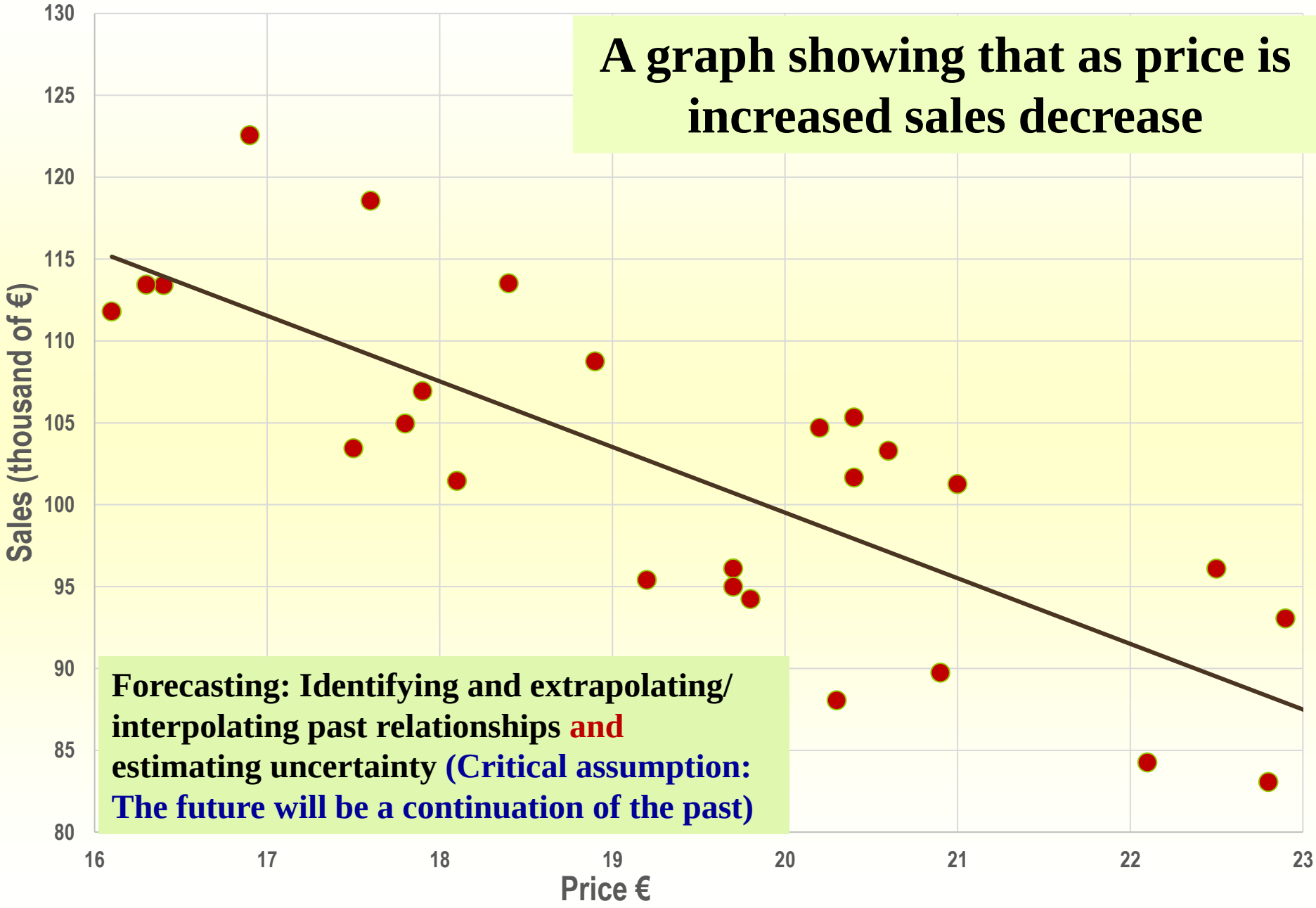

Monthly U.S. Liquor Sales (Logs)
Various types of long-term trends
500
Jan-92
Aug-92
Mar-93
Oct-93
May-94
Dec-94
Jul-95
Feb-96
Sep-96
Apr-97
Nov-97
Jun-98
Jan-99
Aug-99
Mar-00
Oct-00
May-01
Dec-01
Jul-02
Feb-03
Sep-03
Apr-04
Nov-04
Jun-05
Jan-06
Aug-06
Mar-07
Oct-07
May-08
Dec-08
Jul-09
Feb-10
Sep-10
Apr-11
Nov-11
Jun-12
Jan-13
Aug-13
Mar-14
Oct-14
May-15
Dec-15
Jul-16
Feb-17
Sep-17
Apr-18
Nov-18
Jun-19


Population, total, Japan
Millions
135
130
125
120
115
110
105
100
95
90
85
1960 1962 1964 1966 1968 1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018

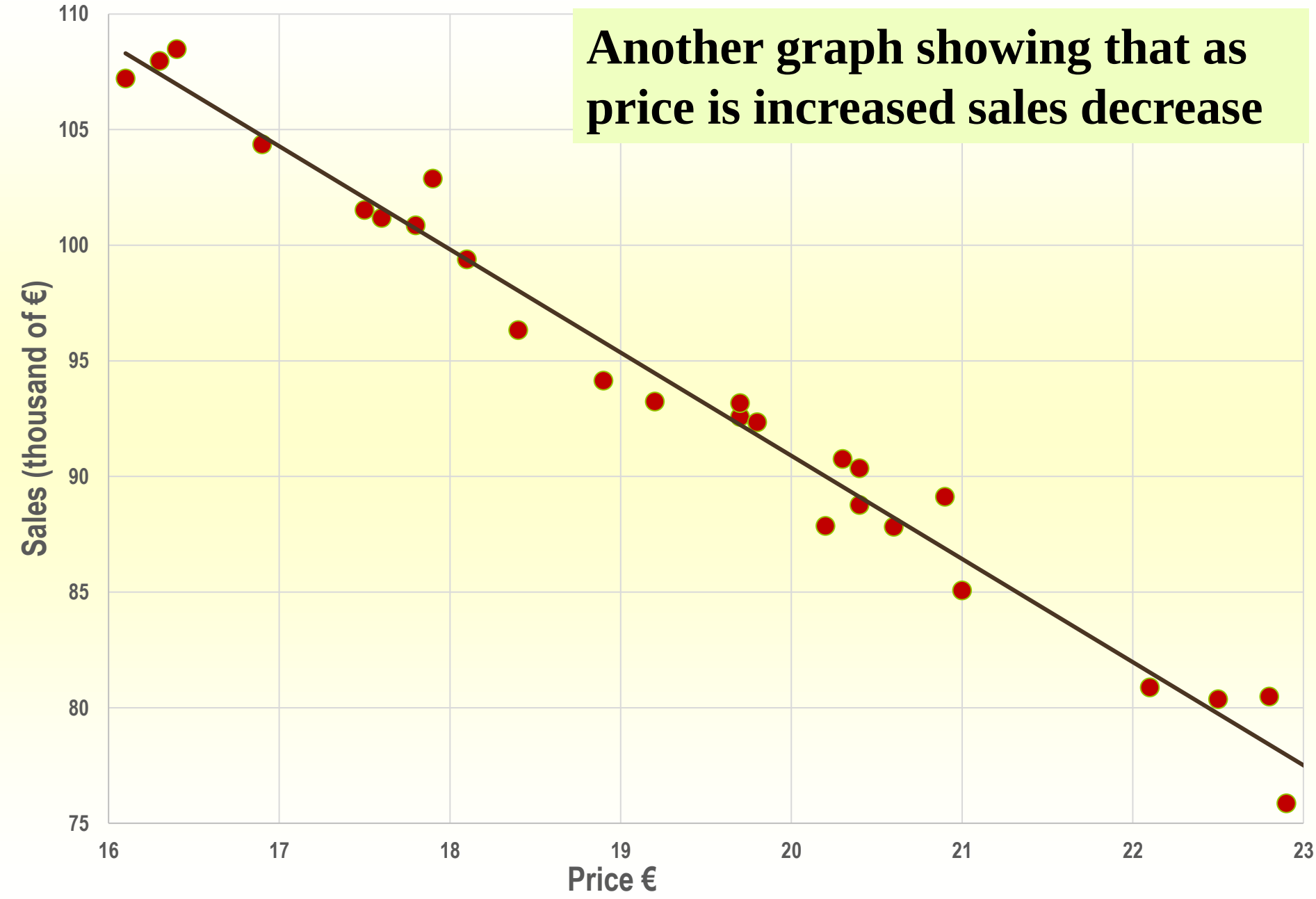

43,325 Hourly Electricity Consumption: California (in Mwh)
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
07/1/2015 08H
08/12/2015 00H
09/22/2015 16H
11/3/2015 08H
12/15/2015 00H
01/25/2016 16H
03/7/2016 08H
04/18/2016 00H
05/29/2016 16H
07/10/2016 08H
08/21/2016 00H
10/1/2016 16H
11/12/2016 08H
12/24/2016 00H
02/3/2017 16H
03/17/2017 08H
04/28/2017 00H
06/8/2017 16H
07/20/2017 08H
08/31/2017 00H
10/11/2017 16H
11/22/2017 08H
01/3/2018 00H
02/13/2018 16H
03/27/2018 08H
05/8/2018 00H
06/18/2018 16H
07/30/2018 08H
09/10/2018 00H
10/21/2018 16H
12/2/2018 08H
01/13/2019 00H
02/23/2019 16H
04/6/2019 08H
05/20/2019 00H
06/30/2019 16H
08/11/2019 08H
09/22/2019 00H
11/2/2019 16H
12/14/2019 08H
01/25/2020 00H
The limitations of statistical methods and the advantages of ML/NN/DL ones

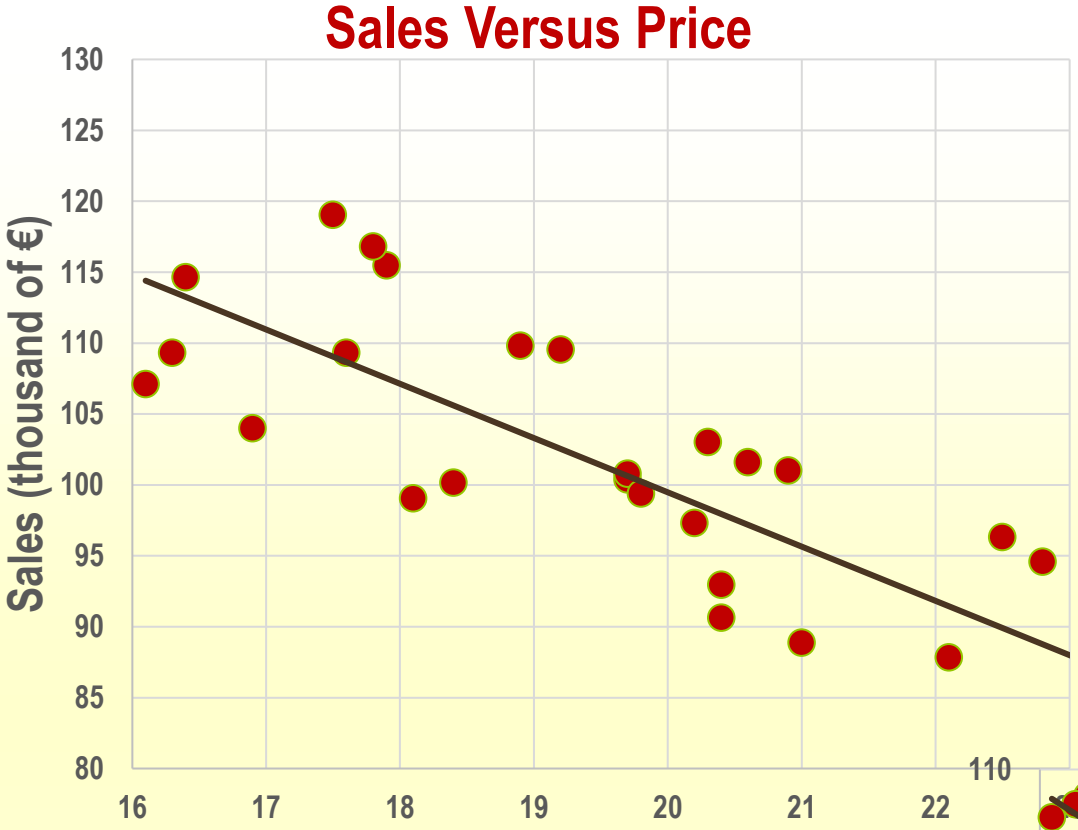
Extrapolating / Interpolating Relationships

Sales Versus Price

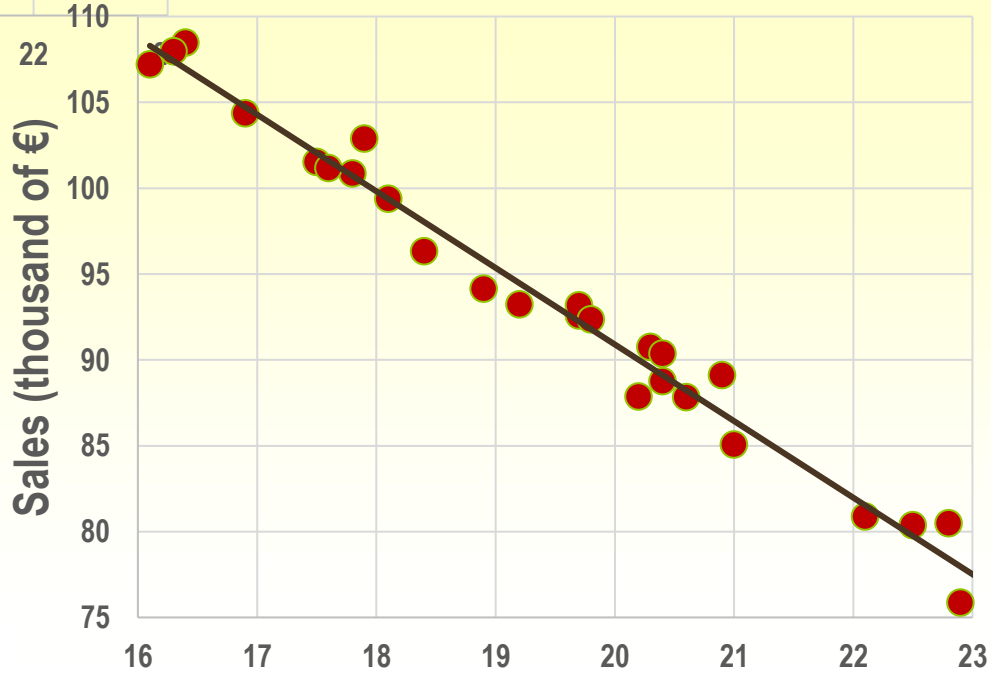


Sales Versus Price





The further away the points are from the line the greater the uncertainty, always assuming the future will be similar to the past



The Statistical Versus the DL/ML approach to Forecasting: Implications

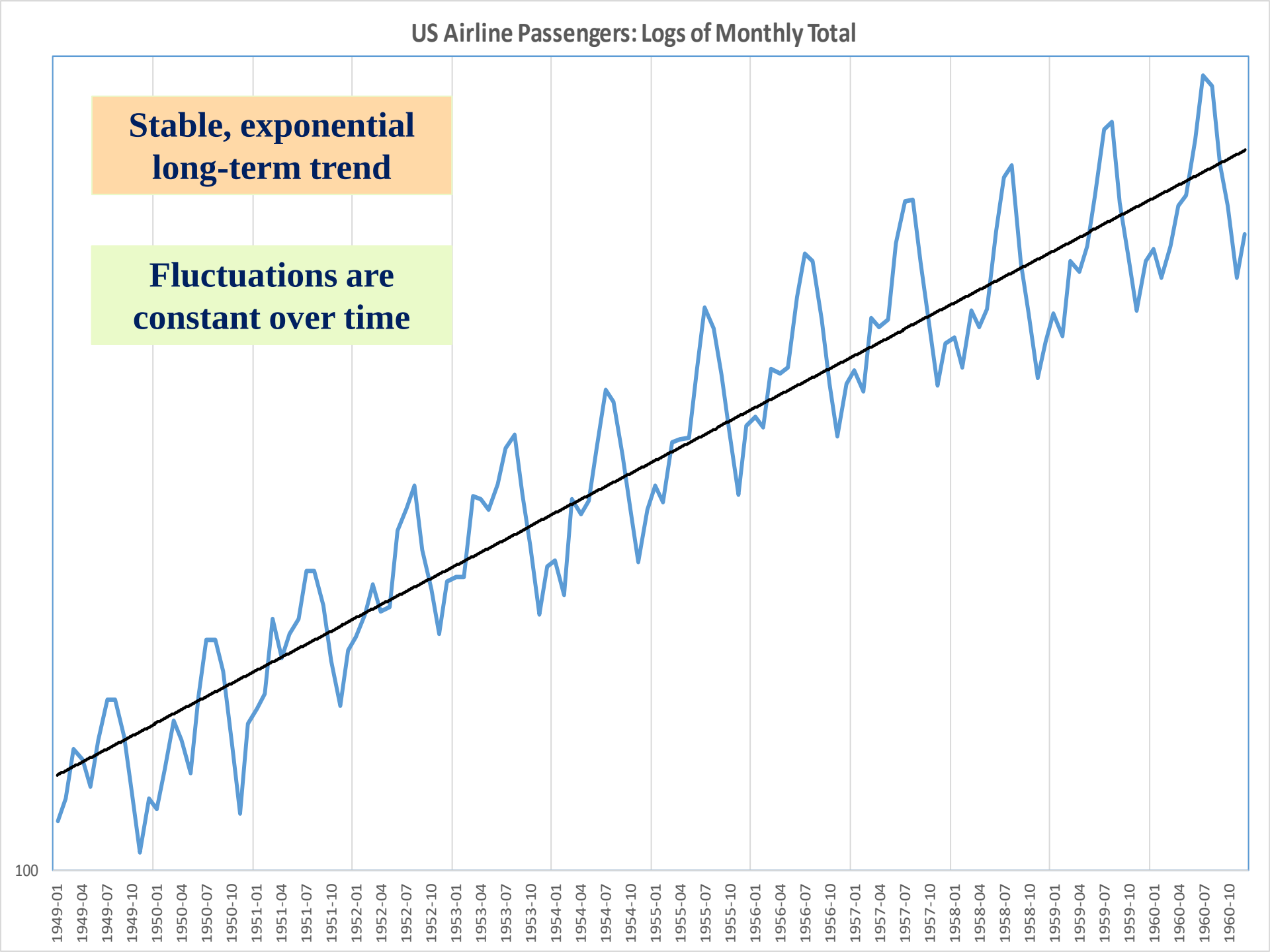
- The role of the statistician in analyzing the data and developing the model to forecast and estimate uncertainty

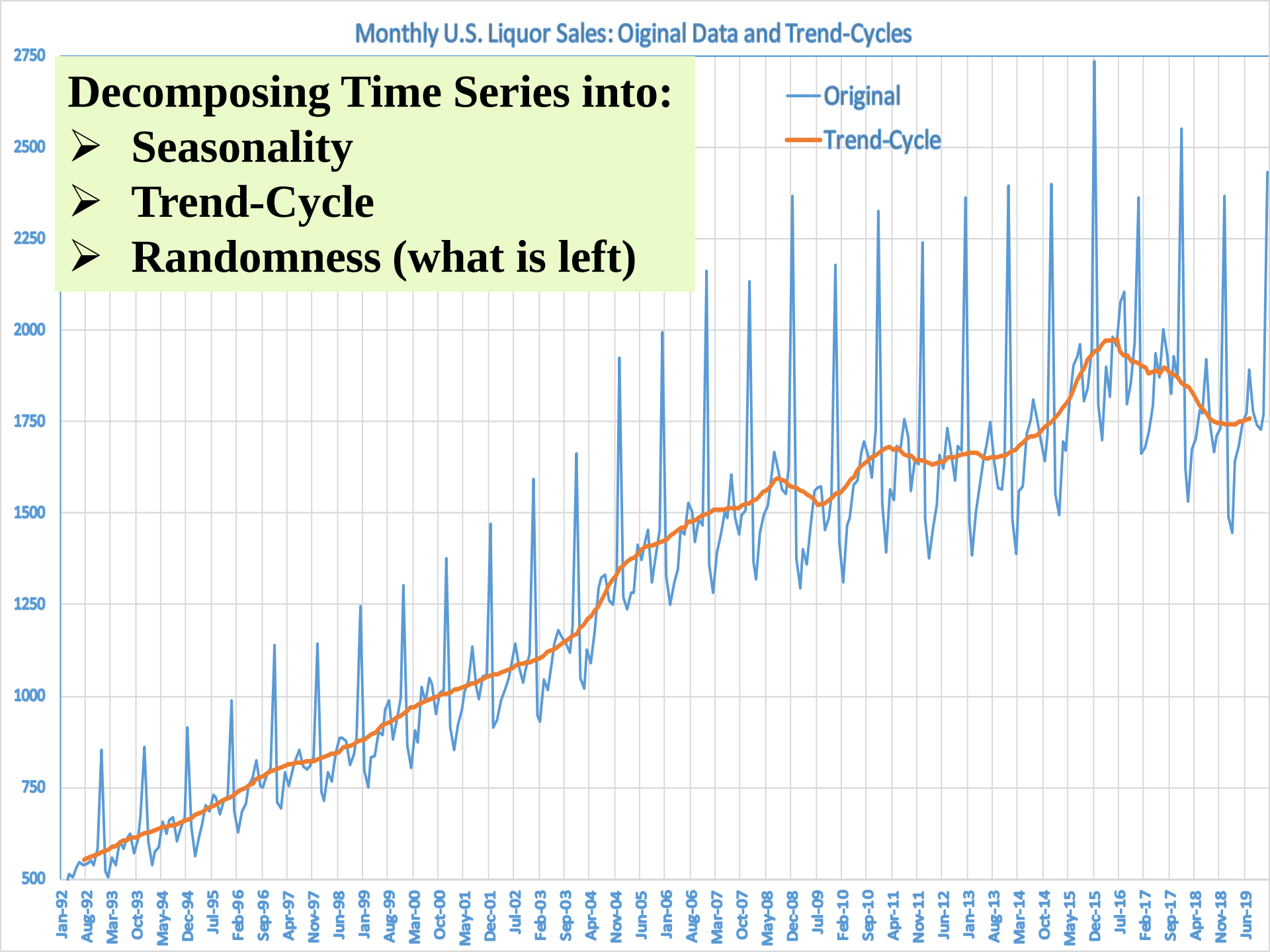
- The DL/ML algorithm does all the work and provide forecasts/estimates of uncertainty using both time series and explanatory variables. The role of data scientist is to finetune the algorithm. The forecasts/estimates of uncertainty are a black box

- Implications for the future of forecasting

Decomposition

- Data = Pattern + Noise
- Time Series Patterns: Seasonality, Trend-Cycle and Randomness ($X_t = S_t+TC_t+R_t$ or $X_t = S_t*TC_t*R_t$)
- Decomposition Methods
- Importance of the 12-months Moving Averages


US Airline Passengers: Logs of Monthly Total
Stable, exponential long-term trend
Fluctuations are constant over time
100
1949-01
1949-04
1949-07
1949-10
1950-01
1950-04
1950-07
1950-10
1951-01
1951-04
1951-07
1951-10
1952-01
1952-04
1952-07
1952-10
1953-01
1953-04
1953-07
1953-10
1954-01
1954-04
1954-07
1954-10
1955-01
1955-04
1955-07
1955-10
1956-01
1956-04
1956-07
1956-10
1957-01
1957-04
1957-07
1957-10
1958-01
1958-04
1958-07
1958-10
1959-01
1959-04
1959-07
1959-10
1960-01
1960-04
1960-07
1960-10


Monthly U.S. Liquor Sales: Oiginal Data and Trend-Cycles
Decomposing Time Series into:
Seasonality
Trend-Cycle
Randomness (what is left)
Original
Trend-Cycle
2750
2500
2250
2000
1750
1500
1250
1000
750
500
Jan-92
Aug-92
Mar-93
Oct-93
May-94
Dec-94
Jul-95
Feb-96
Sep-96
Apr-97
Nov-97
Jun-98
Jan-99
Aug-99
Mar-00
Oct-00
May-01
Dec-01
Jul-02
Feb-03
Sep-03
Apr-04
Nov-04
Jun-05
Jan-06
Aug-06
Mar-07
Oct-07
May-08
Dec-08
Jul-09
Feb-10
Sep-10
Apr-11
Nov-11
Jun-12
Jan-13
Aug-13
Mar-14
Oct-14
May-15
Dec-15
Jul-16
Feb-17
Sep-17
Apr-18
Nov-18
Jun-19

Original Series	12MMA T-C	Seasonal Factors				Seasonal Component
480						0.899
467						0.849
514						0.926
505						0.928
534						0.995
546						1.000
539	554.33	0.972		Jul-92	0.972	1.043
541	557.83	0.970		Jul-93	1.004	1.016
551	561.08	0.982		Jul-94	1.025	0.956
537	564.75	0.951		Jul-95	1.043	0.979
584	567.50	1.029		Jul-96	1.065	1.012
854	573.42	1.489		Jul-97	1.044	1.397
522	576.50	0.905		Jul-98	1.033	0.899
506	582.17	0.869		Jul-99	1.041	0.849
558	589.08	0.947		Jul-00	1.058	0.926
538	590.67	0.911		Jul-01	1.097	0.928
605	596.67	1.014		Jul-02	1.053	0.995
583	604.25	0.965		Jul-03	1.041	1.000
607	604.83	1.004		Jul-04	1.044	1.043
624	611.75	1.020		Jul-05	1.013	1.016
570	614.33	0.928		Jul-06	1.037	0.956
609	615.75	0.989		Jul-07	1.062	0.979
675	619.92	1.089		Jul-08	1.046	1.012
861	624.17	1.379		Jul-09	1.030	1.397
605	627.50	0.964		Jul-10	1.025	0.899
537	632.00	0.850		Jul-11	1.059	0.849
575	635.67	0.905		Jul-12	1.048	0.926
588	638.42	0.921		Jul-13	1.057	0.928
656	640.92	1.024		Jul-14	1.059	0.995
623	640.42	0.973		Jul-15	1.035	1.000
661	644.92	1.025		Jul-16	1.068	1.043
668	648.08	1.031		Jul-17	1.054	1.016
603	650.25	0.927		Jul-18	1.086	0.956
639	653.67	0.978		Jul-19	1.075	0.979
669	658.42	1.016		Avg. Jul.	1.046	1.012
915	662.33	1.381				1.397

The 12 months moving average of 544.33 has no seasonality and little or no randomness

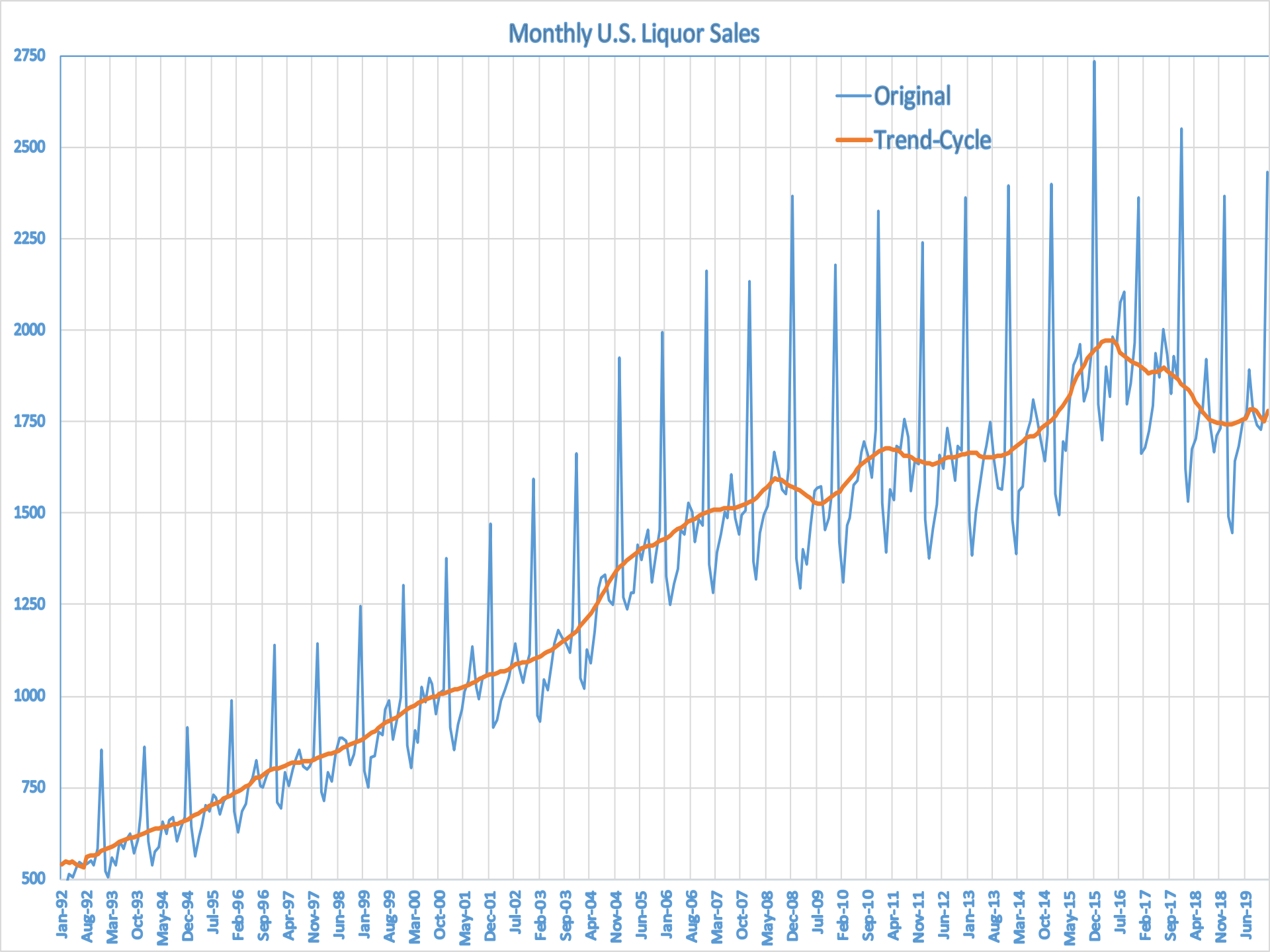
$$X_t = \cancel{S_t} * TC_t * \cancel{R_t}$$

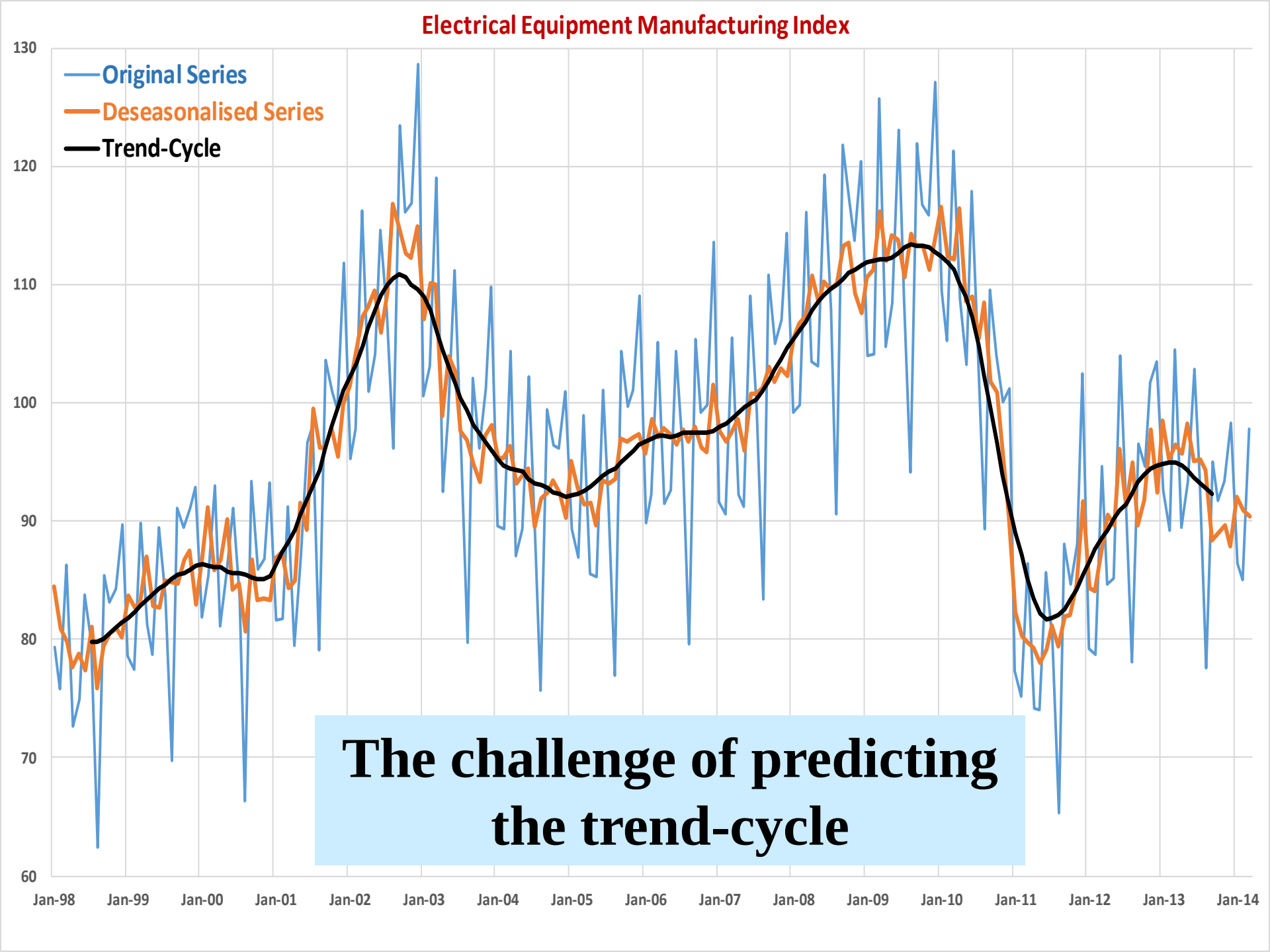
Thus, the 12MMA of 544.33 consist of TC_t only

If we now divide $X_t = S_t * TC_t * R_t$ by the 12MMA or TC

We get left with $(S_t * \cancel{TC_t} * R_t)/\cancel{TC_t} = S_j * R_j$

Averaging S*R for each month provides us with the seasonal indexes


Monthly U.S. Liquor Sales
Original
Trend-Cycle
2750
2500
2250
2000
1750
1500
1250
1000
750
500
Jan-92
Aug-92
Mar-93
Oct-93
May-94
Dec-94
Jul-95
Feb-96
Sep-96
Apr-97
Nov-97
Jun-98
Jan-99
Aug-99
Mar-00
Oct-00
May-01
Dec-01
Jul-02
Feb-03
Sep-03
Apr-04
Nov-04
Jun-05
Jan-06
Aug-06
Mar-07
Oct-07
May-08
Dec-08
Jul-09
Feb-10
Sep-10
Apr-11
Nov-11
Jun-12
Jan-13
Aug-13
Mar-14
Oct-14
May-15
Dec-15
Jul-16
Feb-17
Sep-17
Apr-18
Nov-18
Jun-19


Electrical Equipment Manufacturing Index
Original Series
Deseasonalised Series
Trend-Cycle
130
120
110
100
90
80
70
60
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
The challenge of predicting the trend-cycle

The Value of Decomposition Methods

- They are NOT Black Boxes
- They permit estimating seasonality (often the most valuable component of forecasting) needed for scheduling, planning and budgeting purposes
- They allow to deseasonalize the data to run methods that cannot predict seasonality on their own
- They provide information to concentrate on predicting the Trend-Cycle judgmentally (essential for budgeting purposes) and relate it to economic activity

Types of Forecasting

- Judgmental
  - Unstructured
  - Structured
- Statistical
  - Simple methods
  - Sophisticated methods
  - Combinations
- AI
  - Machine Learning (ML)
  - Deep Learning (DL)
  - Combinations

Judgmental Adjustments to

- **Statistical forecasts**
- **ML/DL forecasts**

Uncertainty

Forecasting and Uncertainty: Four Distinct Types with Different Risk Implications

Forecasting, Uncertainty and Risk

	KNOWN	UNKNOWN
KNOWN	**I. Known/Knowns** (Normal conditions, Law of large numbers, independent events, wisdom of the crowds) Forecasting: Accuracy measurable Uncertainty: Thin tailed and measurable Risks: Manageable (e.g. having inventories)	**III. Unknown/Knowns** (Cognitive biases, Strategic actions, self-fulfilling and self-defeating prophesies, game theory) Forecasting: Purely Judgmental Uncertainty: Extensive/hard to measure Risk: Depends on biases, strategic actions/reactions
UNKNOWN	**II. Known/Unknowns** (Special settings, effects of the next recession on economy/firms, madness of crowds) Forecasting: Inaccuracy can vary considerably Uncertainty: Fat tailed, hard to measure Risks: Can be substantial, tough to manage	**IV. Unknown/Unknowns (Black Swans)** (Black Swans: Low probability high impact events, e.g. implications of the total collapse of global trade) Forecasting: Impossible Uncertainty: Infinite Risks: Unmanageable, need for antifragile strategies

Forecasting and Uncertainty: Four Distinct Types with Different Risk Implications

Forecasting, Uncertainty and Risk

	KNOWN	UNKNOWN
KNOWN	**I. Known/Knowns** (Normal conditions, Law of large numbers, independent events, wisdom of the crowds) Forecasting: Accuracy measurable Uncertainty: Thin tailed and measurable Risks: Manageable (e.g. having inventories)	

The largest company in the world by revenues and the biggest forecasting user

11,766 Stores, 200,000 items per store.
2.3 billion items to forecasts twice a week to adequately supply their retail store and fulfill online orders placed at all times (7X24)

Forecasting and Uncertainty: Four Distinct Types with Different Risk Implications

Forecasting, Uncertainty and Risk

	KNOWN	UNKNOWN
KNOWN	**I. Known/Knowns** (Normal conditions, Law of large numbers, independent events, wisdom of the crowds) Forecasting: Accuracy measurable Uncertainty: Thin tailed and measurable Risks: Manageable (e.g. having inventories)	
UNKNOWN	**II. Known/Unknowns** (Special settings, effects of the next recession on economy/firms, madness of crowds) Forecasting: Inaccuracy can vary considerably Uncertainty: Fat tailed, hard to measure Risks: Can be substantial, tough to manage	

The implications of a recession to individuals, firms and countries, not to mention financial firms and stock markets?

Economy & Business

COVID-19 Induces Deep Global Recession for 2020, Says IMF

By VOA News
October 13, 2020 03:50 PM

The International Monetary Fund is projecting a deep global recession in 2020 because of the COVID-19 pandemic, with global economies expected to shrink by 4.4%.

Speaking Tuesday at the IMF's World Economic Outlook Forum in Boston, IMF chief economist Gita Gopinath said the pandemic shut down business and industry throughout the world.

While most economies reopened, prompting the IMF to improve its current forecast to somewhat over its June prediction, Gopinath said resurgences of the virus and other political uncertainties suggest the global economic recovery will be slow and uneven well into 2021.

Although the infection rate remains high in the United States and is once again rising in many European countries, the world is finding ways to deal with Covid-19. Keeping physical distance and wearing masks in public spaces has become the norm almost everywhere. Are we back to (a new) normal and ready to resume the pre-Covid growth trajectory? A quick look at forecast global GDP reveals the severe impact of the biggest crisis since the Great Depression.

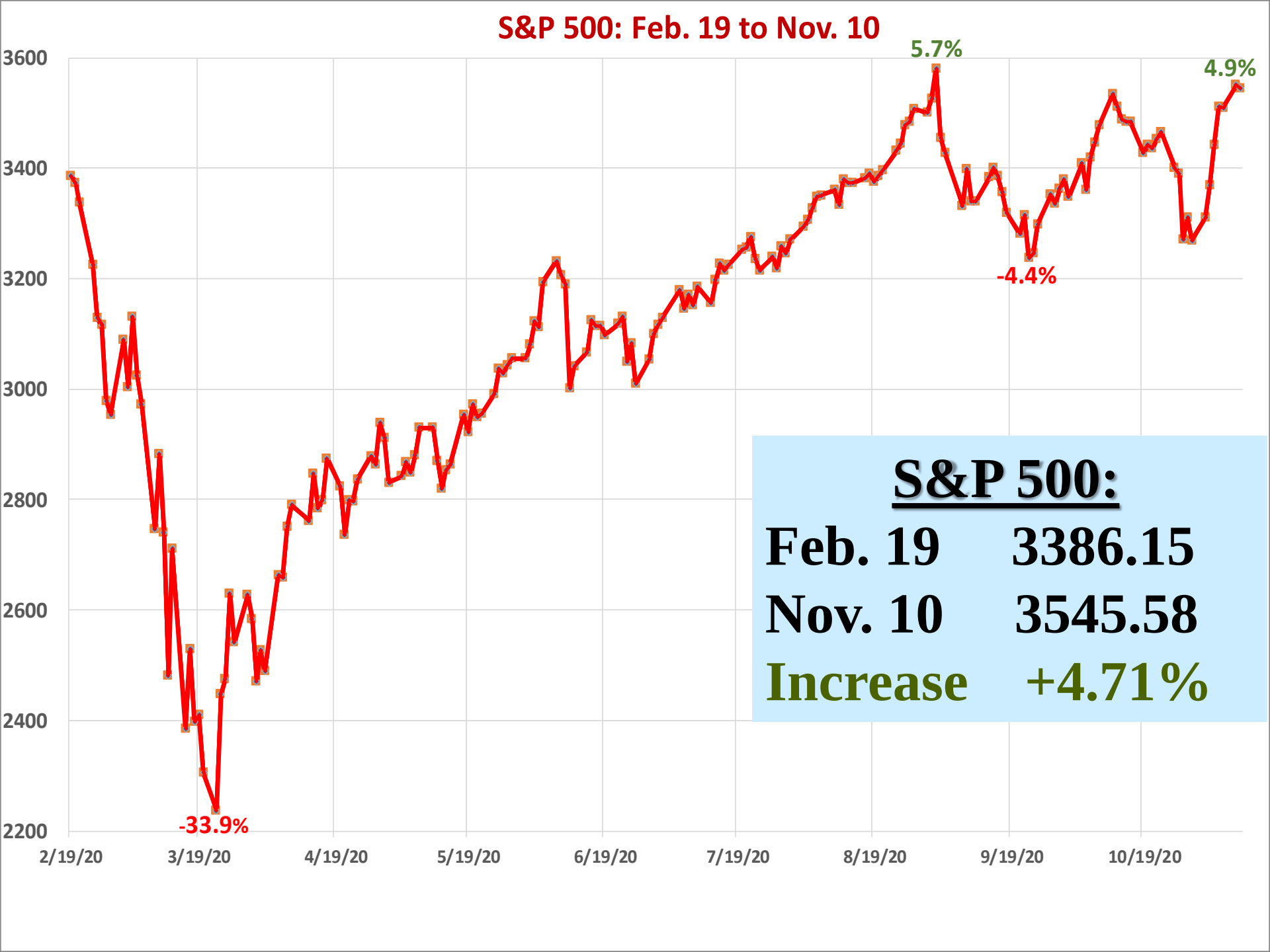
Coronavirus could ‘drag on US economy for a decade'

1 hour ago | Business

The drag on the US economy from the virus pandemic will last almost a decade, according to projections by the Congressional Budget Office (CBO).

It forecasts the outbreak will cut US economic output by 3% between this year and 2030, a loss of $7.9tn (£6.3tn).

The warning comes as tens of millions of people are out of work due to lockdown measures.


S&P 500: Feb. 19 to Nov. 10
3600
3400
3200
3000
2800
2600
2400
2200
2/19/20
3/19/20
4/19/20
5/19/20
6/19/20
7/19/20
8/19/20
9/19/20
10/19/20
5.7%
4.9%
-4.4%
-33.9%
S&P 500:
Feb. 19 3386.15
Nov. 10 3545.58
Increase +4.71%

Forecasting and Uncertainty: Four Distinct Types with Different Risk Implications

Forecasting, Uncertainty and Risk

	KNOWN	UNKNOWN
KNOWN	**I. Known/Knowns** (Normal conditions, Law of large numbers, independent events, wisdom of the crowds) Forecasting: Accuracy measurable Uncertainty: Thin tailed and measurable Risks: Manageable (e.g. having inventories)	**III. Unknown/Knowns** (Cognitive biases, Strategic actions, self-fulfilling and self-defeating prophesies, game theory) Forecasting: Purely Judgmental Uncertainty: Extensive/hard to measure Risk: Depends on biases, strategic actions/reactions **The toilet paper panic**
UNKNOWN	**II. Known/Unknowns** (Special settings, effects of the next recession on economy/firms, madness of crowds) Forecasting: Inaccuracy can vary considerably Uncertainty: Fat tailed, hard to measure Risks: Can be substantial, tough to manage	

A NEW YORK TIMES BUSINESS BESTSELLER

"As entertaining and thought-provoking as *The Tipping Point* by Malcolm Gladwell. . . . *The Wisdom of Crowds* ranges far and wide."
—*The Boston Globe*

THE WISDOM OF CROWDS

JAMES SUROWIECKI

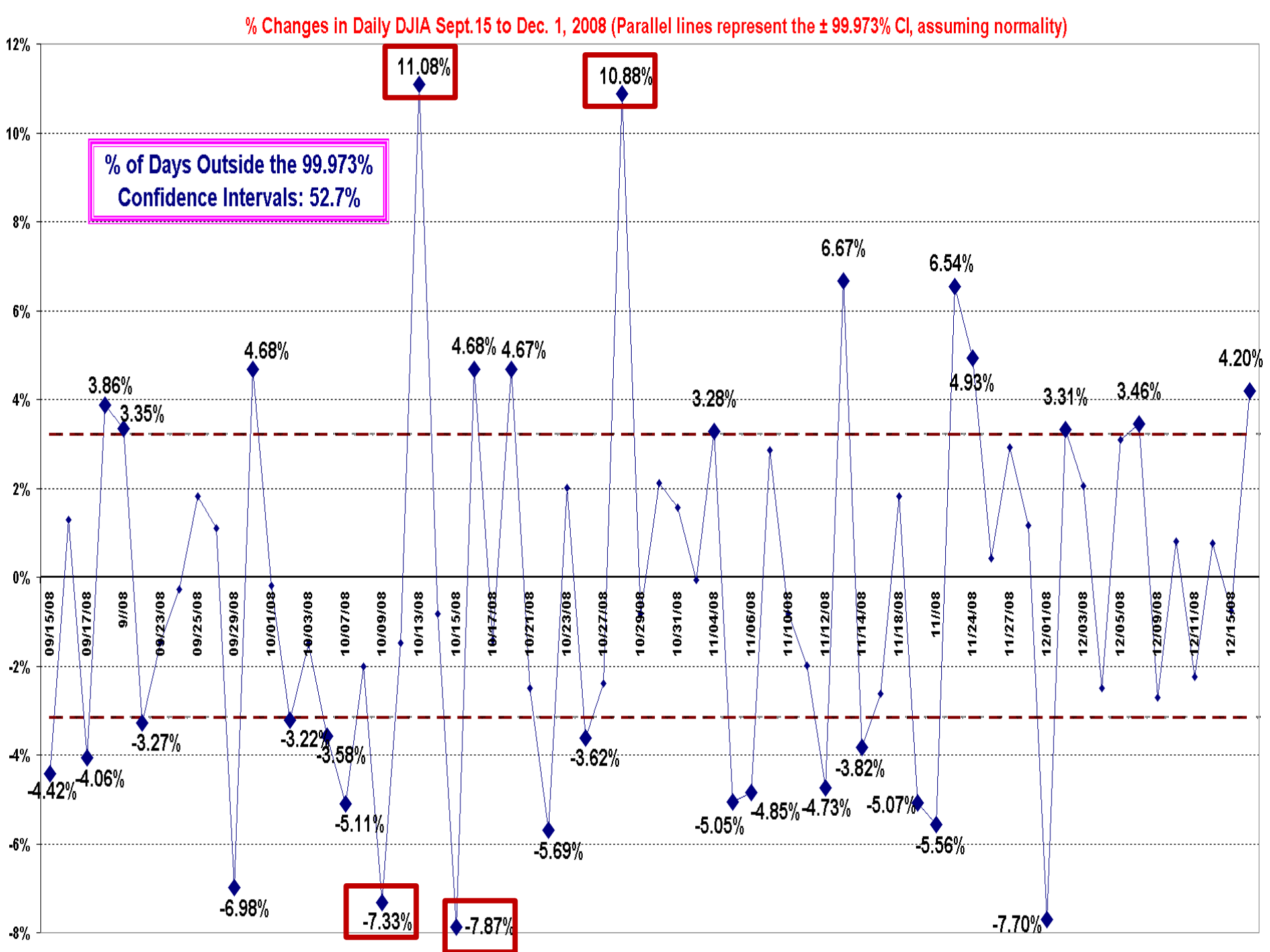
WITH A NEW AFTERWORD BY THE AUTHOR

Internationally Best selling Author of THE STRANGE DEATH OF EUROPE

THE MADNESS OF CROWDS

GENDER, IDENTITY, MORALITY

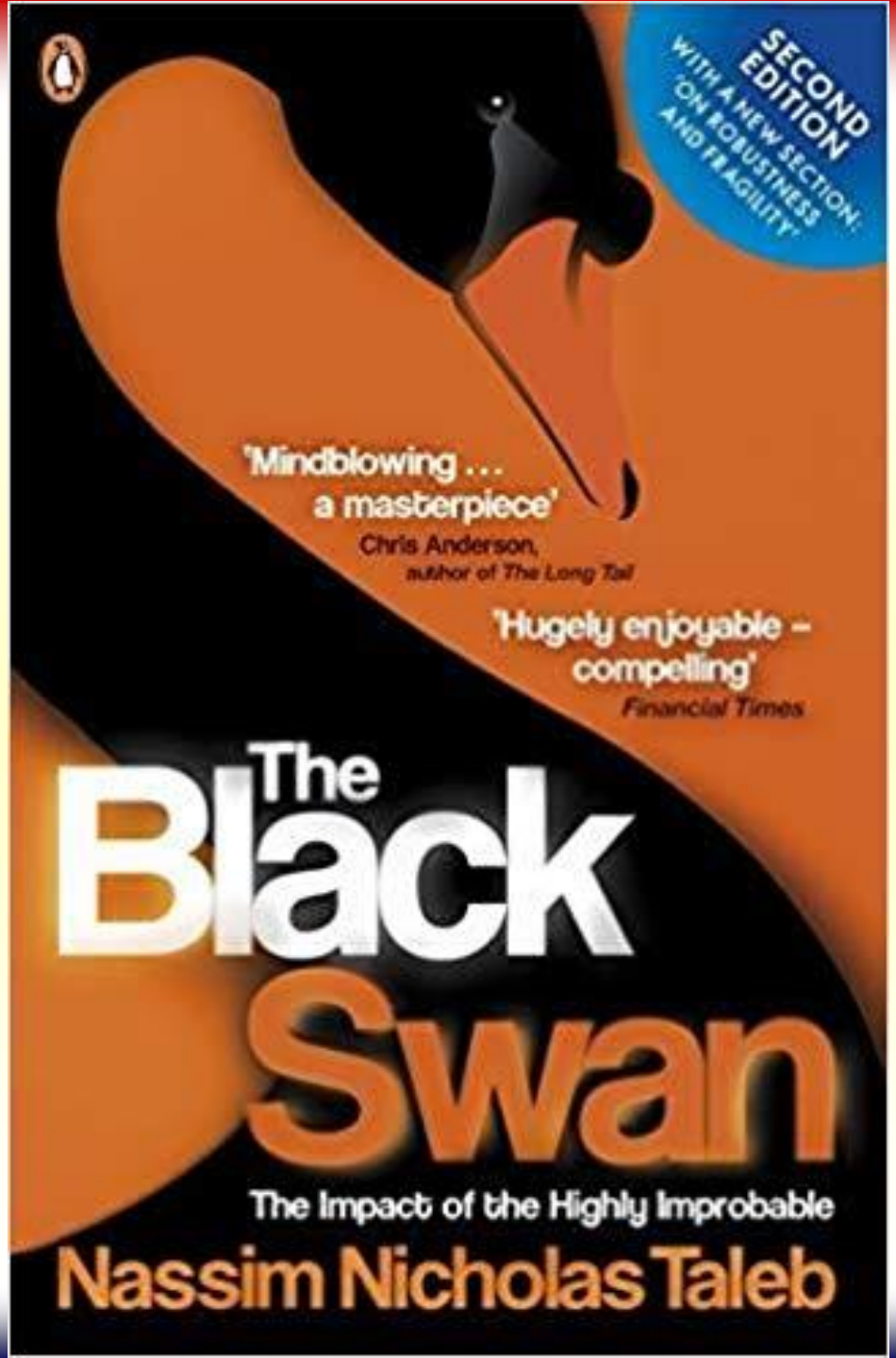
DOUGLAS MURRAY


% Changes in Daily DJIA Sept.15 to Dec. 1, 2008 (Parallel lines represent the ± 99.973% CI, assuming normality)
% of Days Outside the 99.973% Confidence Intervals: 52.7%
12%
10%
8%
6%
4%
2%
0%
-2%
-4%
-6%
-8%
11.08%
10.88%
6.67%
6.54%
4.93%
4.68%
4.68%
4.67%
4.20%
3.86%
3.35%
3.28%
3.31%
3.46%
-4.42%
-4.06%
-3.27%
-3.22%
-3.58%
-5.11%
-6.98%
-7.33%
-7.87%
-5.69%
-3.62%
-5.05%
-4.85%
-4.73%
-3.82%
-5.07%
-5.56%
-7.70%
09/15/08
09/17/08
9//08
09/23/08
09/25/08
09/29/08
10/01/08
10/03/08
10/07/08
10/09/08
10/13/08
10/15/08
10/17/08
10/21/08
10/23/08
10/27/08
10/29/08
10/31/08
11/04/08
11/06/08
11/10/08
11/12/08
11/14/08
11/18/08
11//08
11/24/08
11/27/08
12/01/08
12/03/08
12/05/08
12/09/08
12/11/08
12/15/08

Forecasting and Uncertainty: Four Distinct Types with Different Risk Implications

Forecasting, Uncertainty and Risk

	KNOWN	UNKNOWN
KNOWN	**I. Known/Knowns** (Normal conditions, Law of large numbers, independent events, wisdom of the crowds) Forecasting: Accuracy measurable Uncertainty: Thin tailed and measurable Risks: Manageable (e.g. having inventories)	**III. Unknown/Knowns** (Cognitive biases, Strategic actions, self-fulfilling and self-defeating prophesies, game theory) Forecasting: Purely Judgmental Uncertainty: Extensive/hard to measure Risk: Depends on biases, strategic actions/reactions
UNKNOWN	**II. Known/Unknowns** (Special settings, effects of the next recession on economy/firms, madness of crowds) Forecasting: Inaccuracy can vary considerably Uncertainty: Fat tailed, hard to measure Risks: Can be substantial, tough to manage	**IV. Unknown/Unknowns (Black Swans)** (Black Swans: Low probability high impact events, e.g. implications of the total collapse of global trade) Forecasting: Impossible Uncertainty: Infinite Risks: Unmanageable, need for antifragile strategies



Swans: Black Gray and White

UNIVERSITY *of* NICOSIA

Thank you
Vangelis will now continue