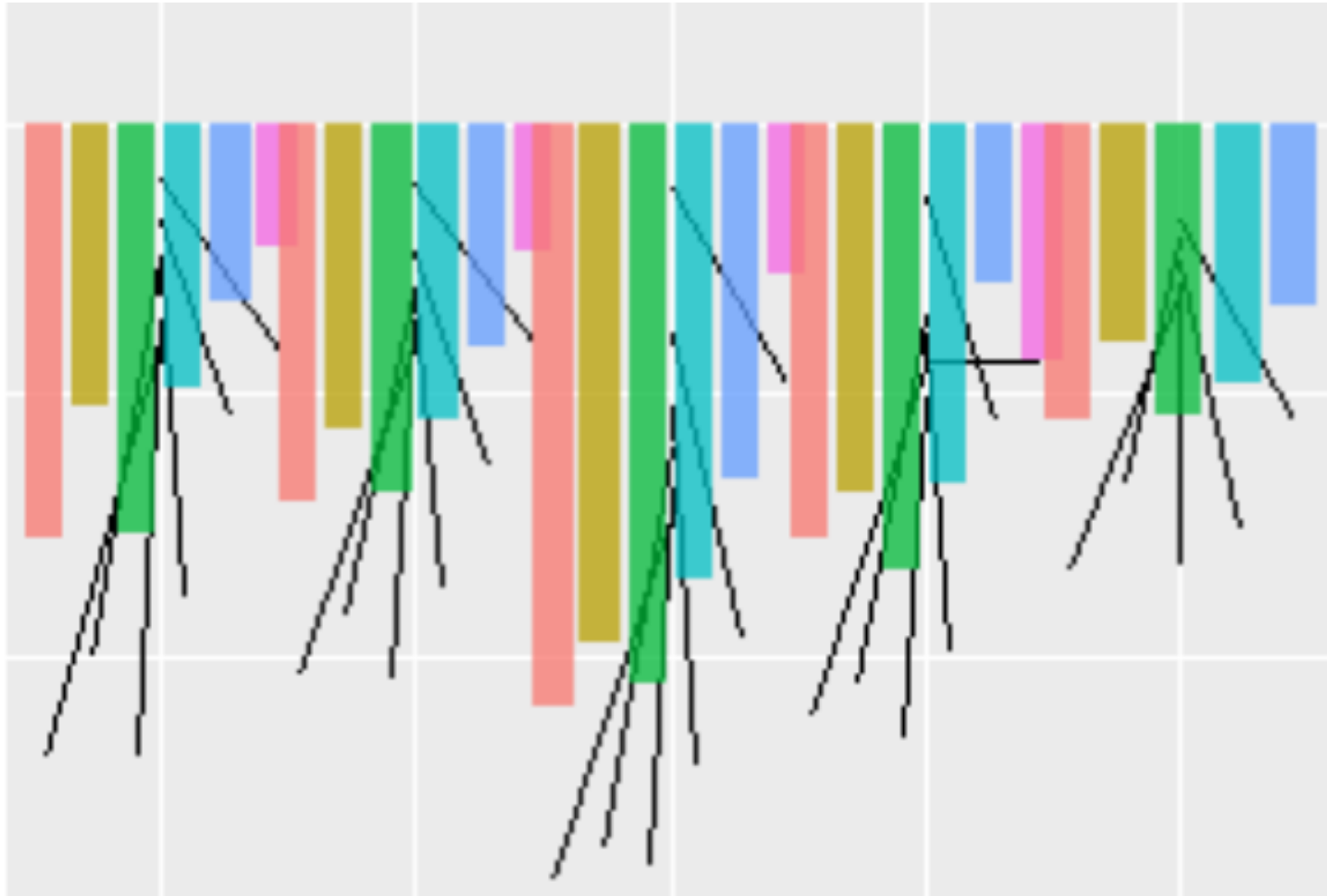# Data Visualization

Len Kiefer, February 2021

What can be [charted] at all can be [charted] clearly; and whereof one cannot [chart] thereof one must be silent.
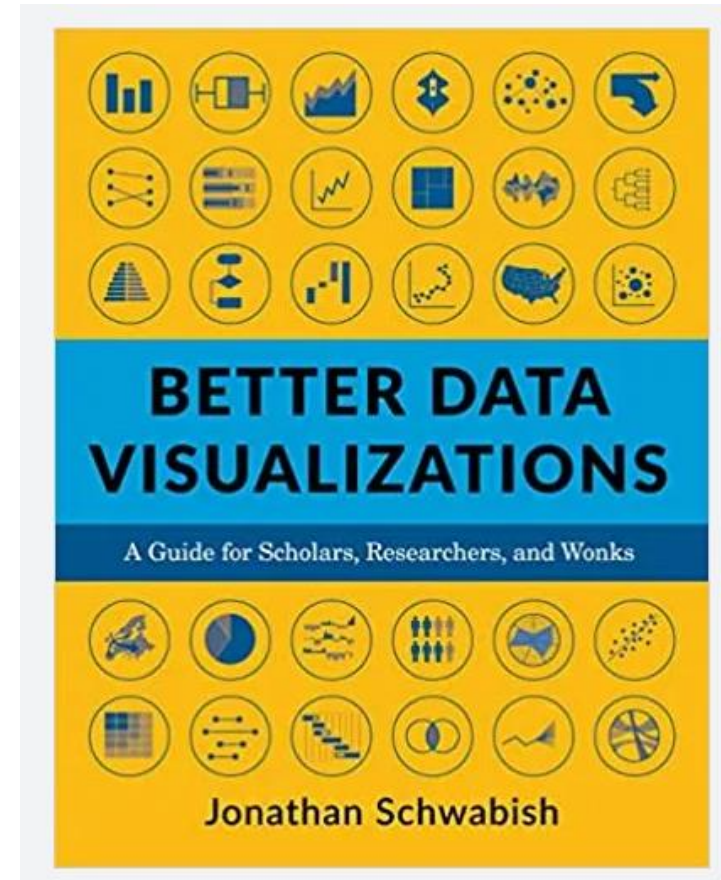
Talk overview

- Guidelines for better data visualizations

- A case study: using data visualization to help talk about how the COVID-19 pandemic has affected the economy and housing markets

- Exploratory visualizations versus visualizations to communicate

Data Visualization Guidelines

Five Guidelines from Jon Schwabish's *Better Data Visualizations*

1. Show the Data

2. Reduce the Clutter

3. Integrate Graphics and Text

4. Small Multiples

5. Start with Gray

https://policyviz.com/2021/02/11/inside-better-data-visualizations-a-guide-for-scholars-researchers-and-wonks/

Using data visualization to help talk about how the COVID-19 pandemic has affected the economy and housing markets

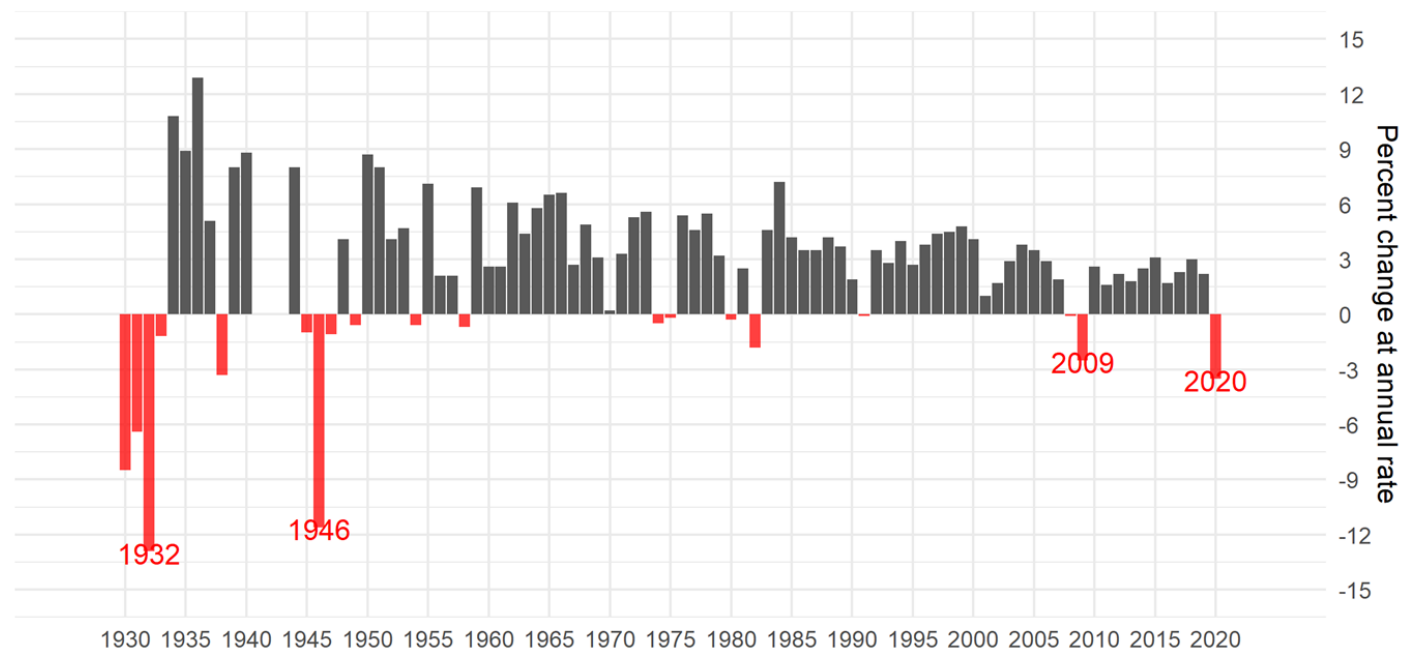## Initial Jobless Claims as a % of Labor Force (seasonally adjusted)

0.400%

0.350%

0.300%

Jan   Apr   Jul
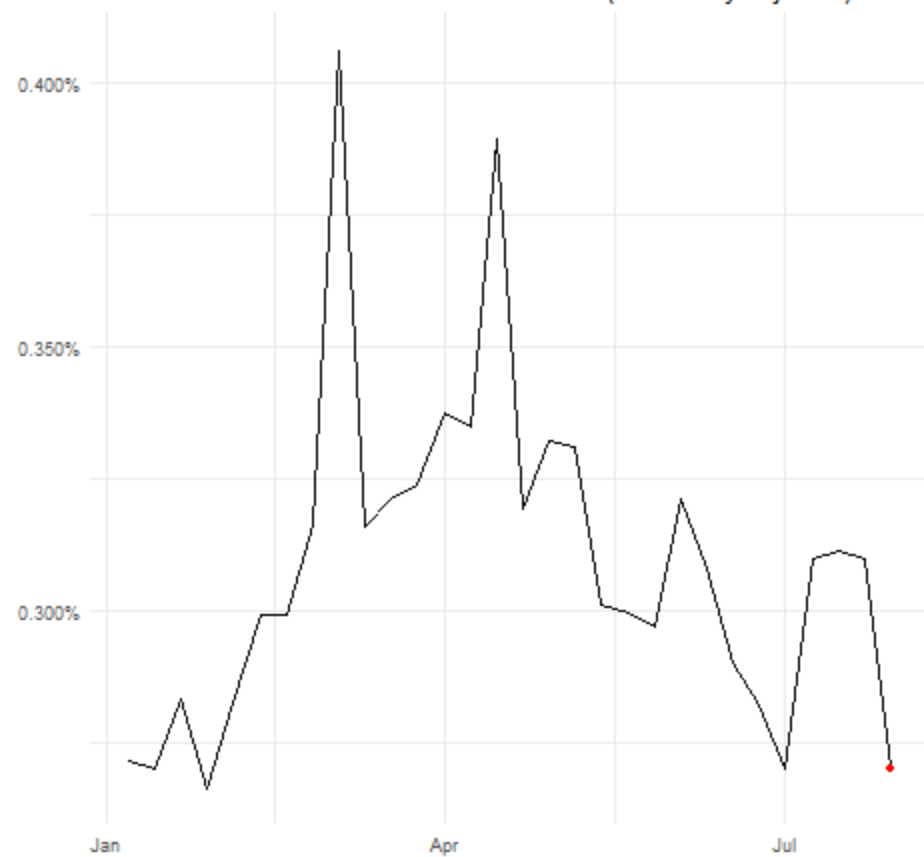
@lenkiefer Source: U.S. Department of Labor

US economy contracts

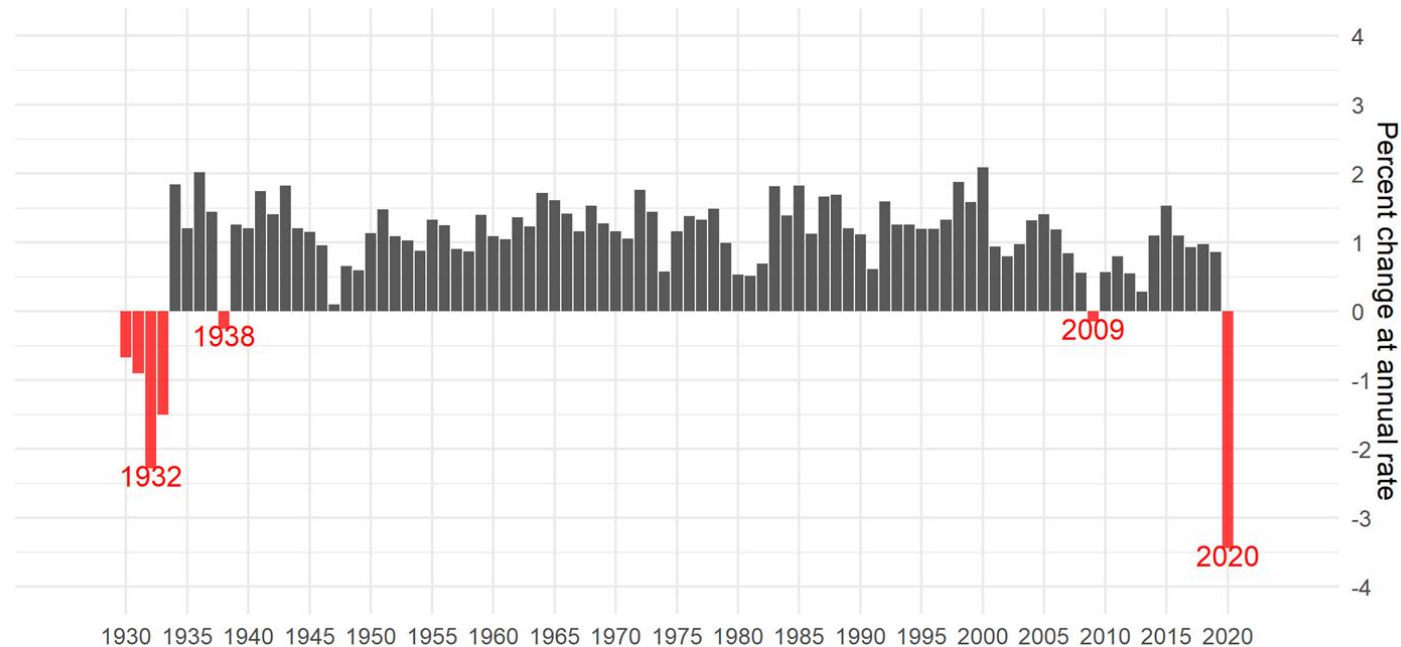**US Real GDP in 2020 contracted the most since 1946**

US Real GDP Growth

@lenkiefer Source U.S. Bureau of Economic Analysis,
Table 1.1.2. Contributions to Percent Change in Real Gross Domestic Product
Annual data from 1930 to 2020

Most of the decline in 2020 GDP was due to contraction in personal consumption expenditures on services

Personal consumption expenditures on services

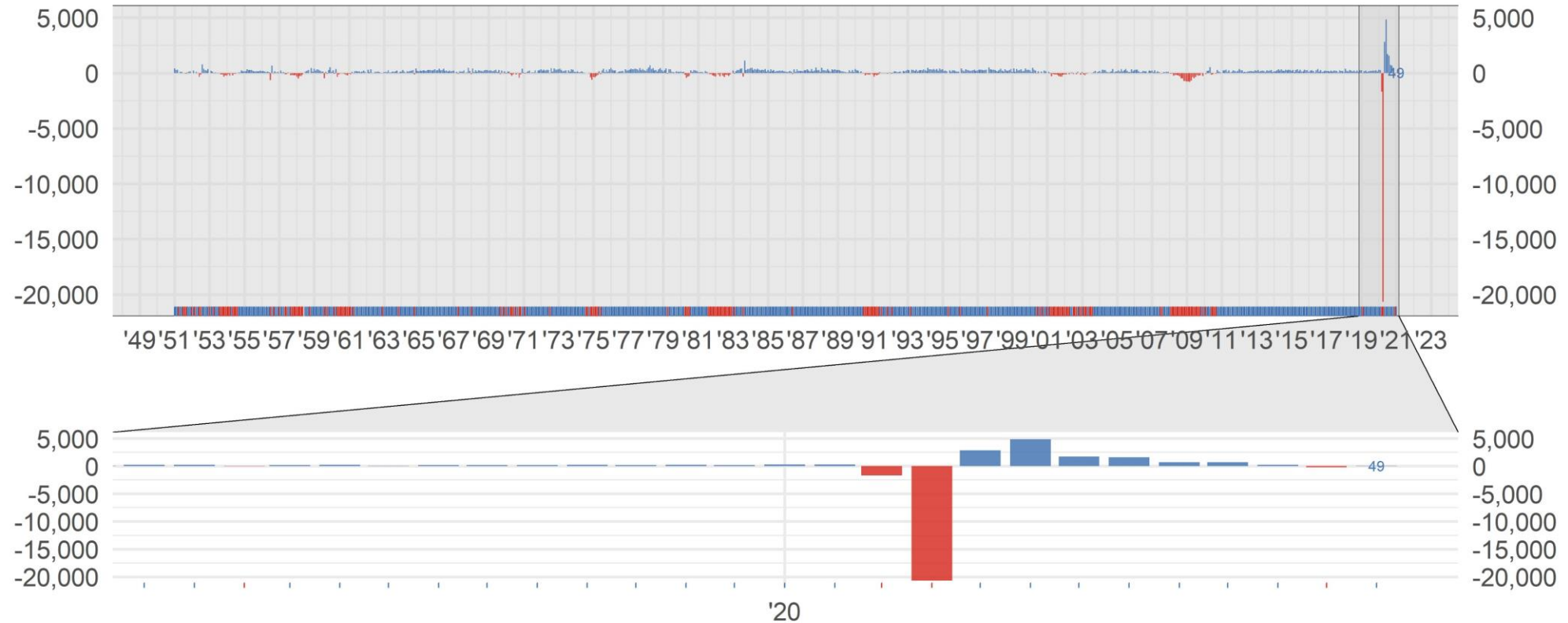Contribution to Percent Change in Real Gross Domestic Product

@lenkiefer Source U.S. Bureau of Economic Analysis,
Table 1.1.2. Contributions to Percent Change in Real Gross Domestic Product
Annual data from 1930 to 2020

US job growth decelerates

US job growth returns to positive (barely) in January 2021
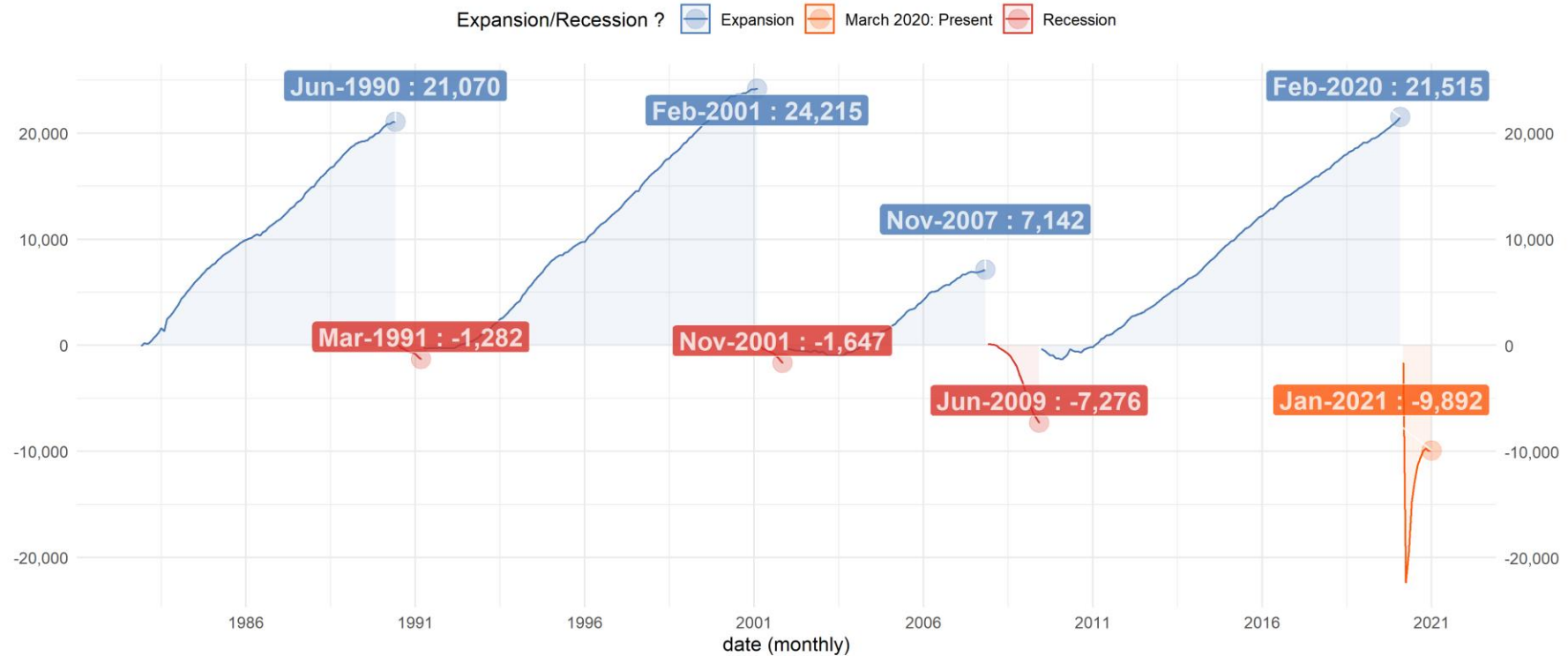
Monthly change in U.S. nonfarm employment (1000s, SA)

@lenkiefer Source: U.S. Bureau of Labor Statistics, blue (red) ticks indicate months when job growth was positive (negative)

The US economy is down over 9 million payroll jobs since Feb 2020

Cumulative U.S. nonfarm payroll employment growth (1000s) in expansion/recession
labels indicate cumulative growth through end of expansion/recession

Expansion/Recession ?   ◯ Expansion   ◯ March 2020: Present   ◯ Recession

- Jun-1990 : 21,070
- Feb-2001 : 24,215
- Feb-2020 : 21,515
- Nov-2007 : 7,142
- Mar-1991 : -1,282
- Nov-2001 : -1,647
- Jun-2009 : -7,276
- Jan-2021 : -9,892

date (monthly)

@lenkiefer Source: U.S. Bureau of Labor Statistics All Employees: Total Nonfarm Payrolls, retrieved from BLS, Feb 5, 2021. NBER recession dates

How did the housing market respond?
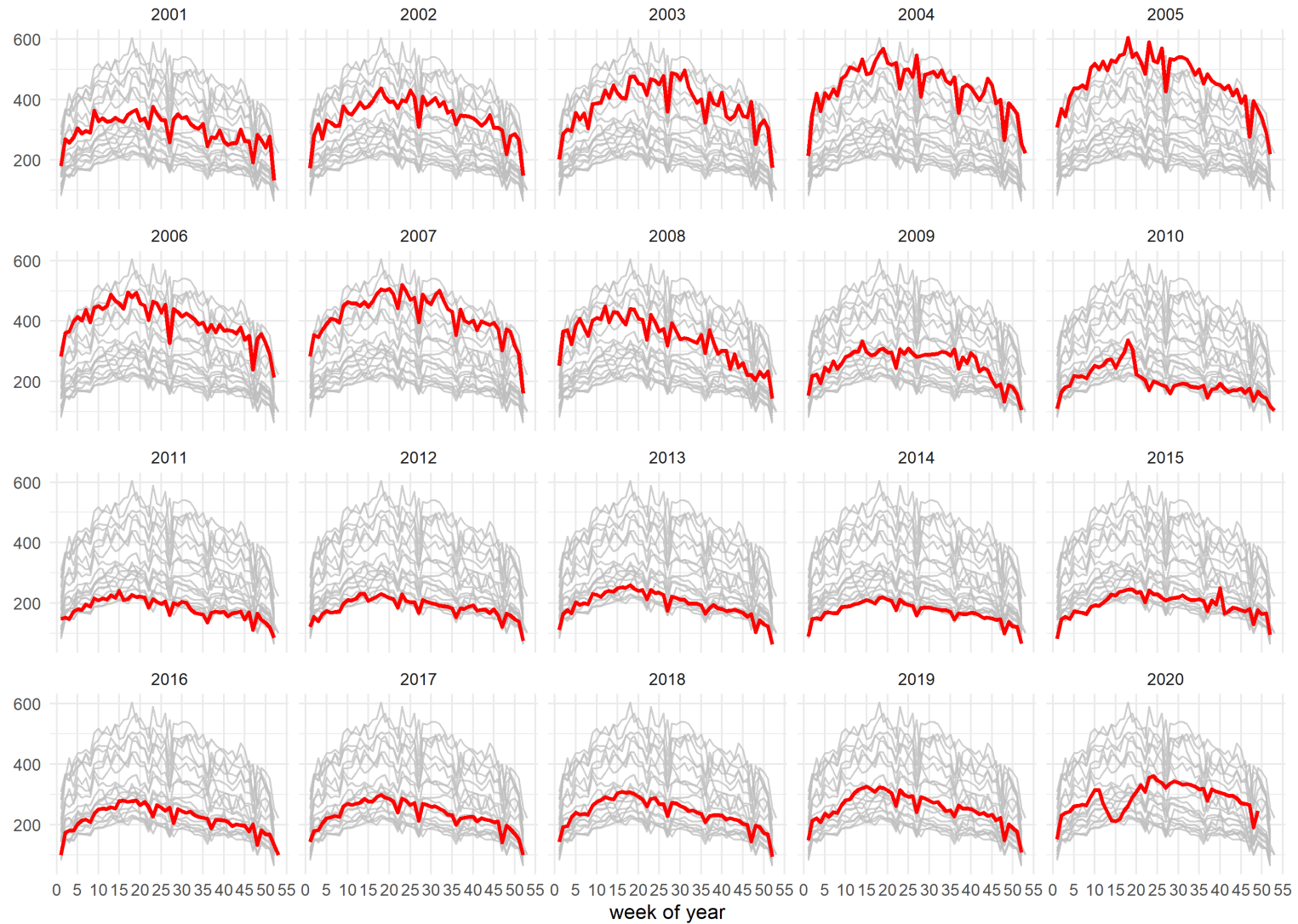
U.S. Home Purchase Mortgage Applications

52-week percent change in seasonally adjusted purchase mortgage applications index
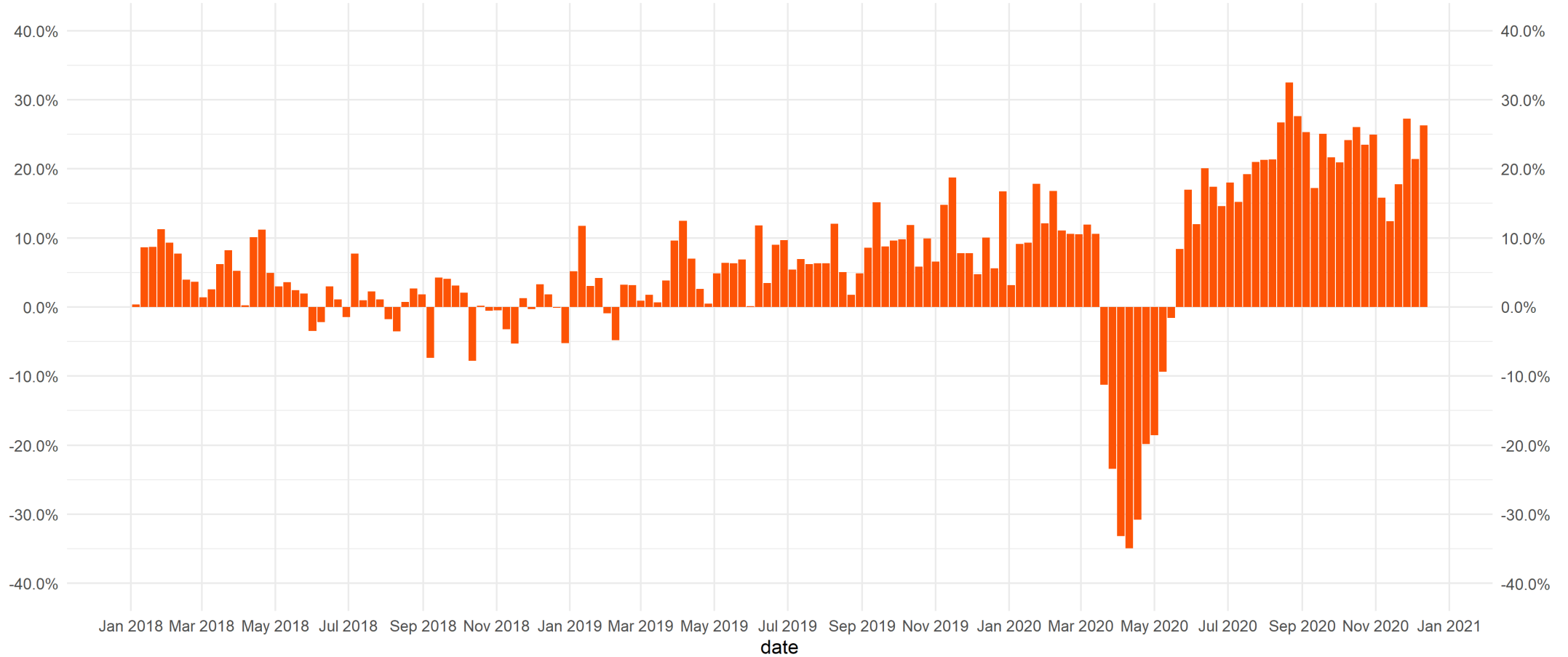
@lenkiefer Source: Mortgage Bankers Association, data through December 11, 2020
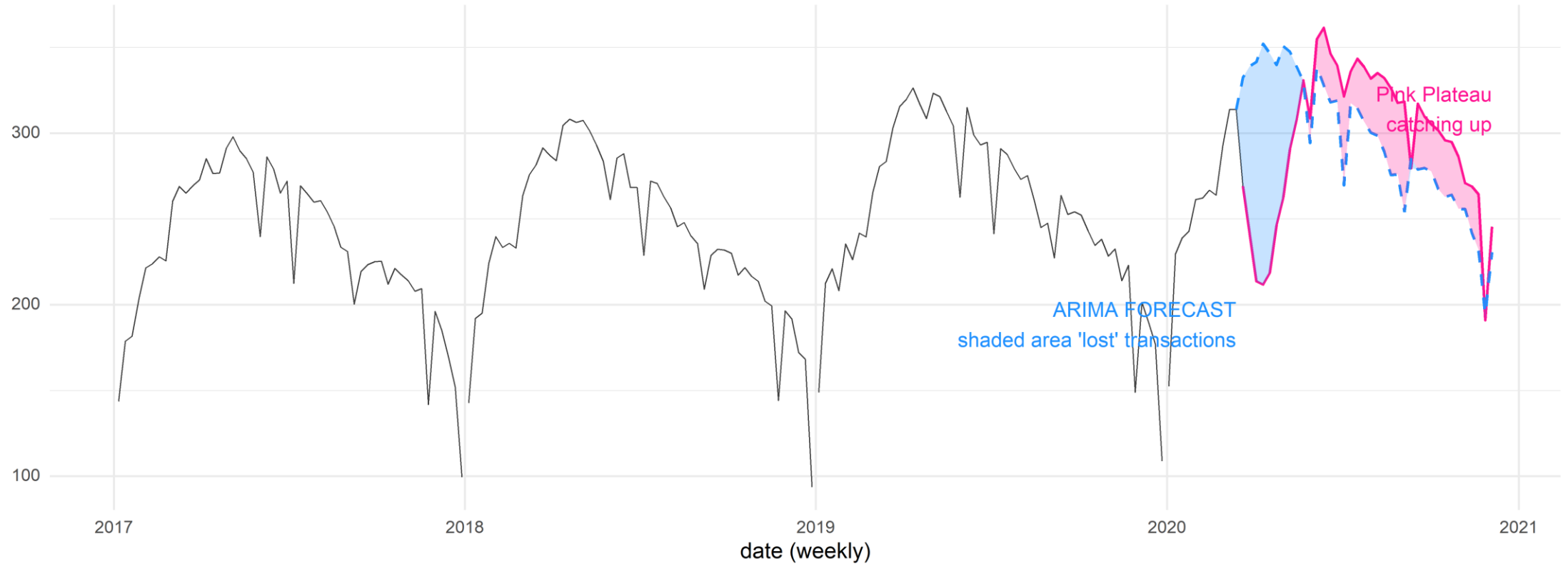
U.S. Mortgage Purchase Activity Rebounds

Purchase Application Index (Mar 16, 1990 =100, not seasonally adjusted)
Gray lines all years 2001-2020

@lenkiefer Source: Mortgage Bankers Association, data through December 04, 2020
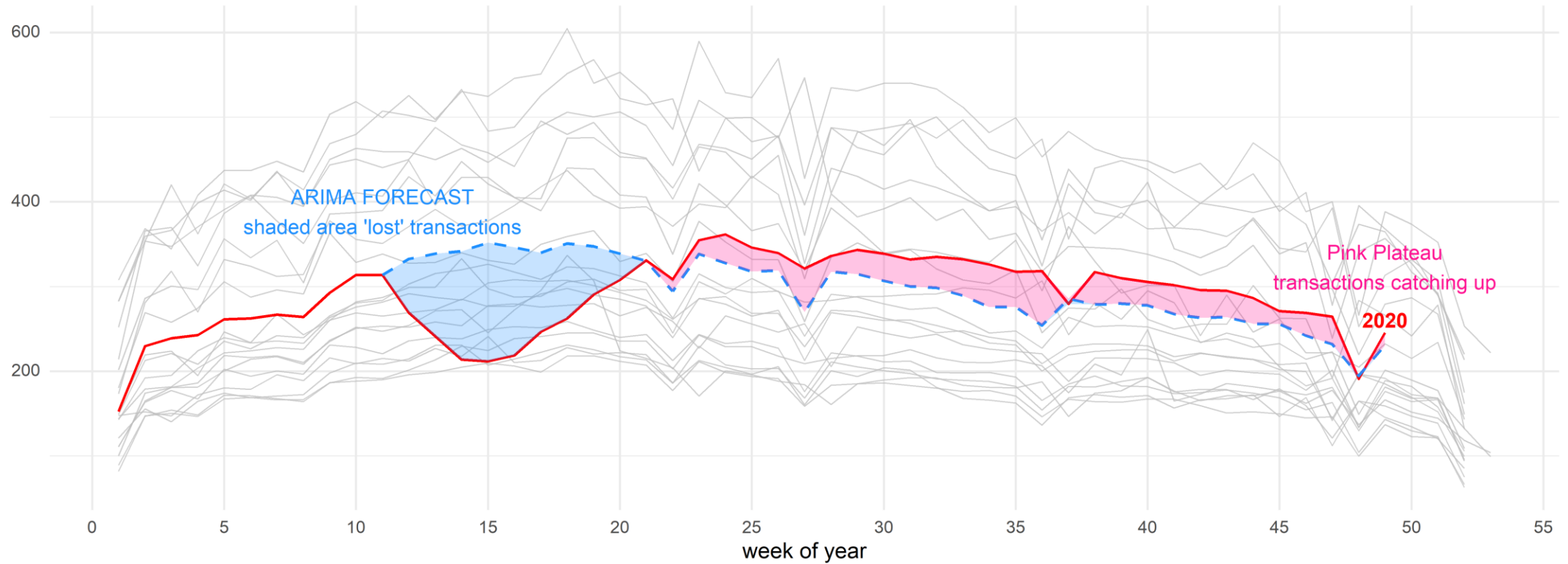
U.S. Mortgage Purchase Activity Rebounds

Purchase Application Index (Mar 16, 1990 =100, not seasonally adjusted) Gray lines all years 2001-2019

ARIMA FORECAST

shaded area 'lost' transactions

Pink Plateau catching up

300

200

100

2017   2018   2019   2020   2021

date (weekly)

@lenkiefer Source: Mortgage Bankers Association, data through December 04, 2020
Seasonal autoregressive $(1,1,0)(1,1,0)_{52}$ Blue ARIMA forecast (extrapolated from 2020-03-13), orange actuals from 2020-03-13 forward.

U.S. Mortgage Purchase Activity Rebounds

Purchase Application Index (Mar 16, 1990 =100, not seasonally adjusted) Gray lines all years 2001-2019

ARIMA FORECAST

shaded area 'lost' transactions

Pink Plateau
transactions catching up

2020

week of year

600

400

200

0   5   10   15   20   25   30   35   40   45   50   55

@lenkiefer Source: Mortgage Bankers Association, data through December 04, 2020
Seasonal autoregressive $(1,1,0)(1,1,0)_{52}$

Cumulative total home purchase mortgage appplications by year

dotted line ARIMA forecast for 2020 starting March 13
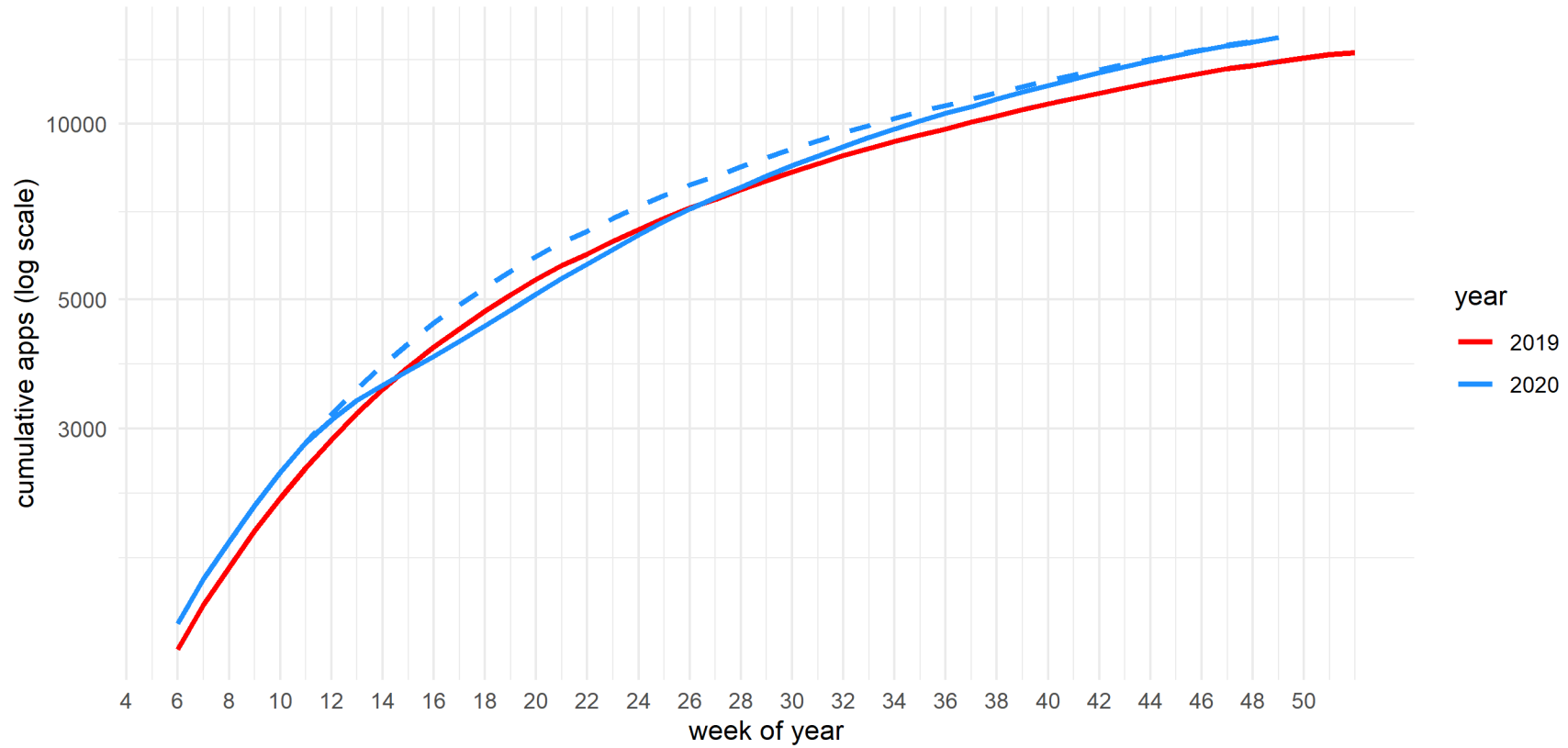
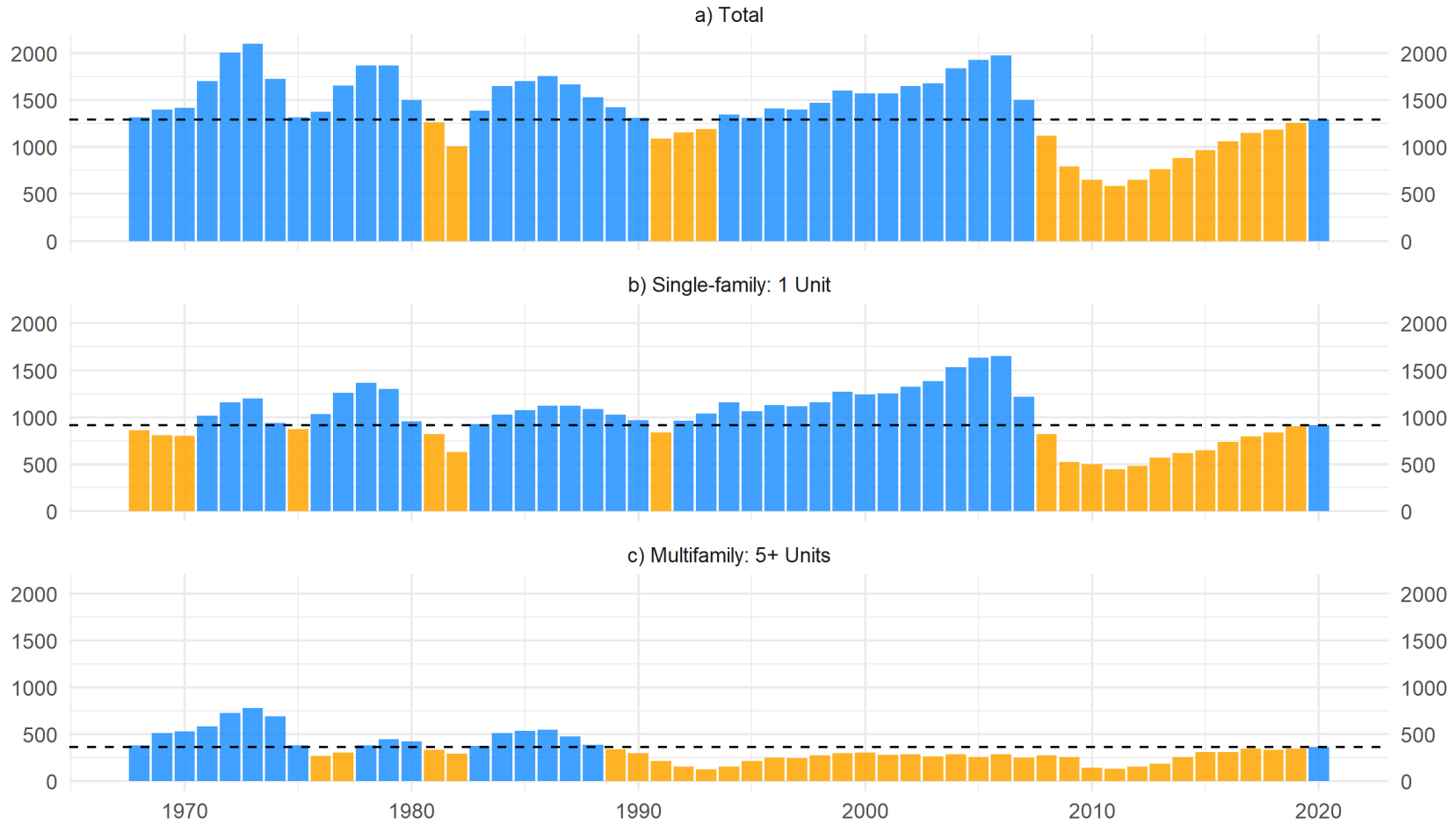@lenkiefer Source: Mortgage Bankers Association, data through December 04, 2020

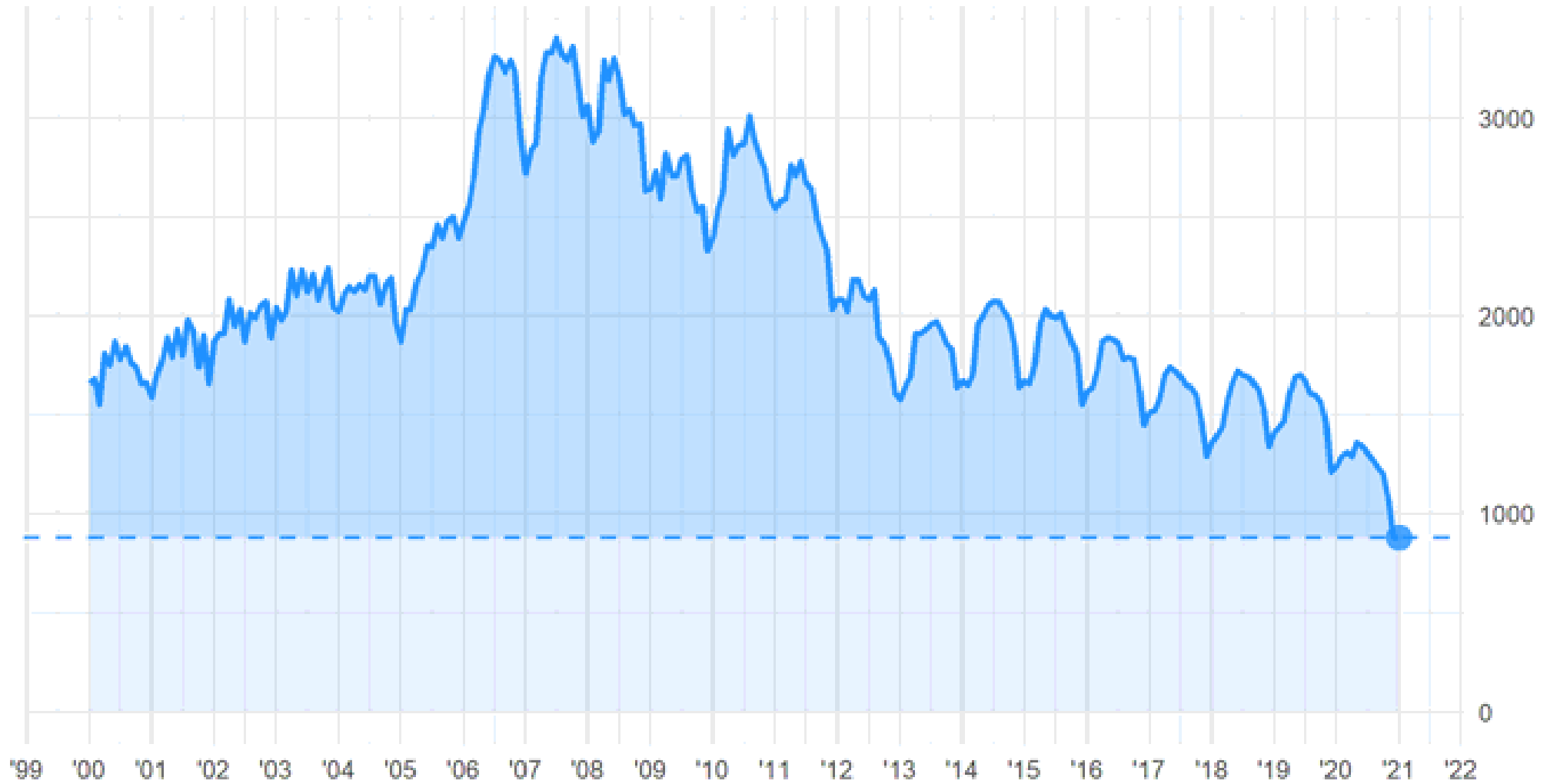# U.S. housing completions (1968-2020)

annual housing completions (1000s)

US annual housing completions relative to 2020   ■ <2020   ■ >=2020

a) Total

b) Single-family: 1 Unit

c) Multifamily: 5+ Units

@lenkiefer Source: U.S. Census Bureau and Department of Housing and Urban Development
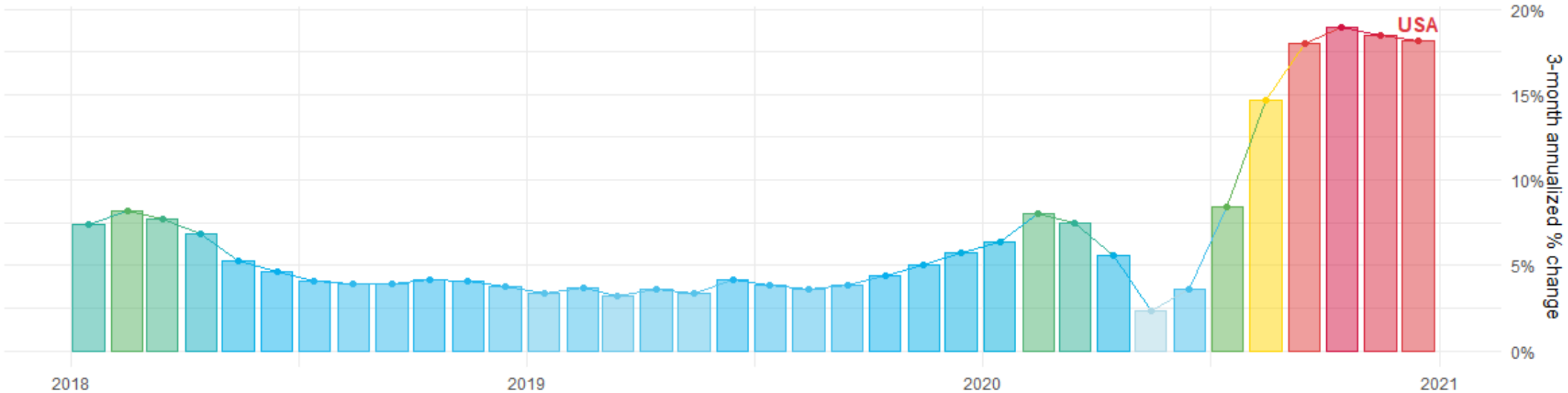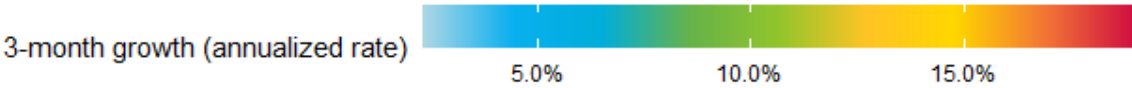
Tight home sales inventory

Number of US single-family homes available for sale, (1000s, NSA)

@lenkiefer Source: National Association of Realtors, dotted line January 2021
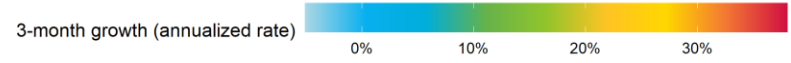
House Price Growth (USA)

Jan 1975-Dec 2020

3-month growth (annualized rate)

5.0%   10.0%   15.0%

USA

3-month annualized % change

20%

15%

10%

5%

0%

2018   2019   2020   2021

@lenkiefer Source: Freddie Mac House Price Index, seasonally adjusted

House Price Growth by State

Jan 2018-Dec 2020

3-month growth (annualized rate)

0%   10%   20%   30%

WI   VT   NH   ME

WA   ID   MT   ND   MN   IL   MI   NY   MA

OR   NV   WY   SD   IA   IN   OH   PA   NJ   CT   RI

CA   UT   CO   NE   MO   KY   WV   VA   MD   DE

AZ   NM   KS   AR   TN   NC   SC   DC

OK   LA   MS   AL   GA

HI   AK   TX   FL

3-month annualized % change

@lenkiefer Source: Freddie Mac House Price Index, seasonally adjusted

Exploratory vs Explanatory

Mortgage rate trends

U.S. weekly average 30-year fixed mortgage rate (percent)

@lenkiefer Source: Freddie Mac Primary Mortgage Market Survey through February 18, 2021

Mortgage rates over 5 decades

U.S. Weekly Average 30-year fixed mortgage rate April 2, 1971 to December 10, 2020
Line weekly value, dark shaded area from decade average to weekly value

1971-1980: 9.4   1981-1990: 12.3   1991-2000: 7.9   2001-2010: 6.0   2011-2020: 3.9

date (weekly)
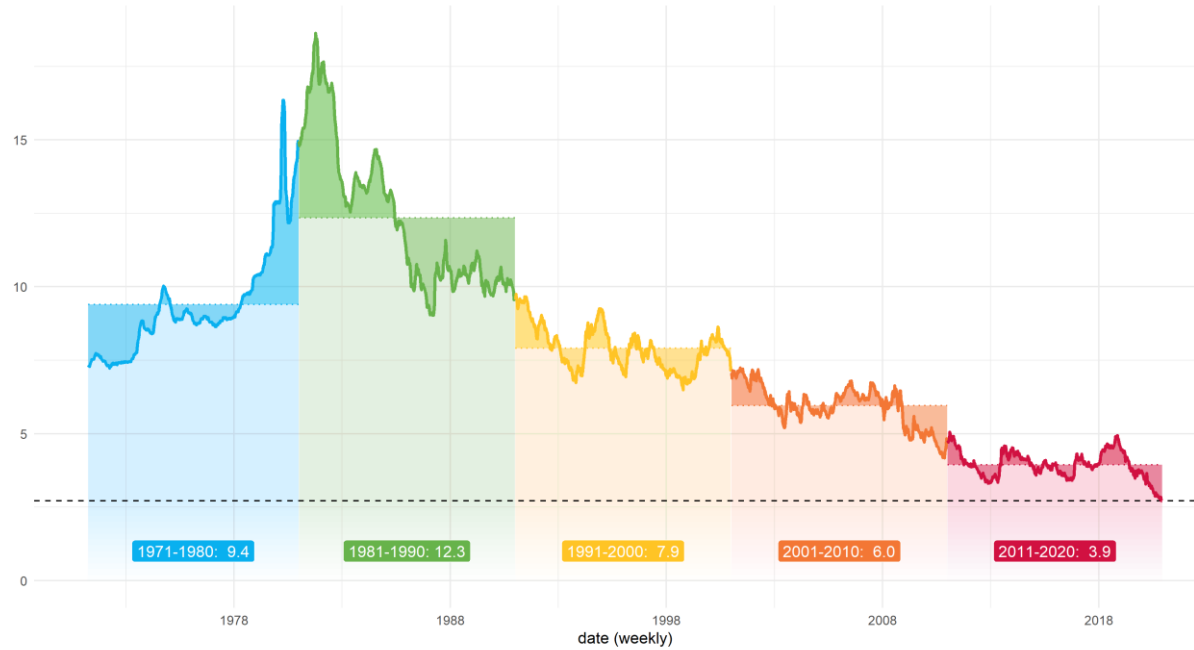
@lenkiefer Source: Freddie Mac Primary Mortgage Market Survey

Estimated density over weekly values

Ticks at bottom weekly observations, dotted line value for December 10, 2020
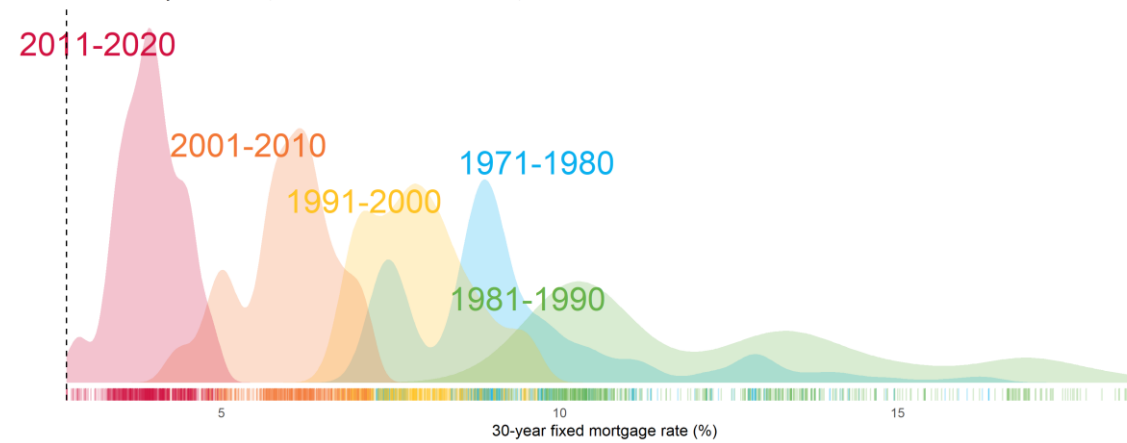
2011-2020

2001-2010

1991-2000

1971-1980

1981-1990

30-year fixed mortgage rate (%)

Distribution over weekly mortgage rates by year
Curves are densities fit to weekly observations for each year

1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
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2001
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2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

30-year fixed mortgage rate (%)

@lenkiefer Source: Freddie Mac Primary Mortgage Market Survey,
Dotted line at 2.71% average for week of December 10, 2020

Distribution over weekly mortgage rates by year
Curves are densities fit to weekly observations for each year, dots weekly values
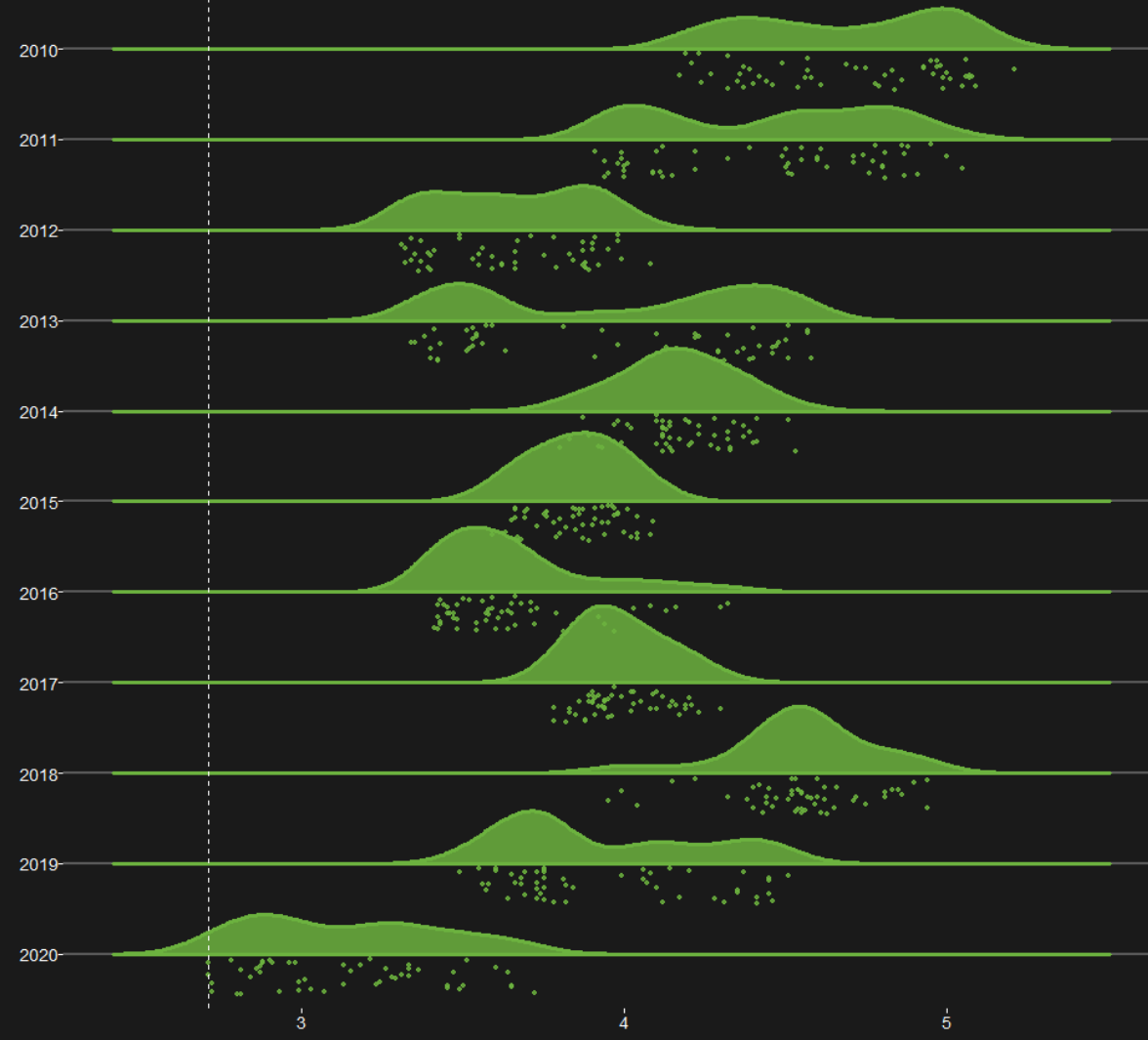
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

3   4   5
30-year fixed mortgage rate (%)

@lenkiefer Source: Freddie Mac Primary Mortgage Market Survey,
Dotted line at 2.71% average for week of December 10, 2020

The shadow of higher mortgage rates looms over the housing market

Mortgage rates Trends

U.S. Weekly Average 30-year fixed mortgage rate (%)

date (weekly)
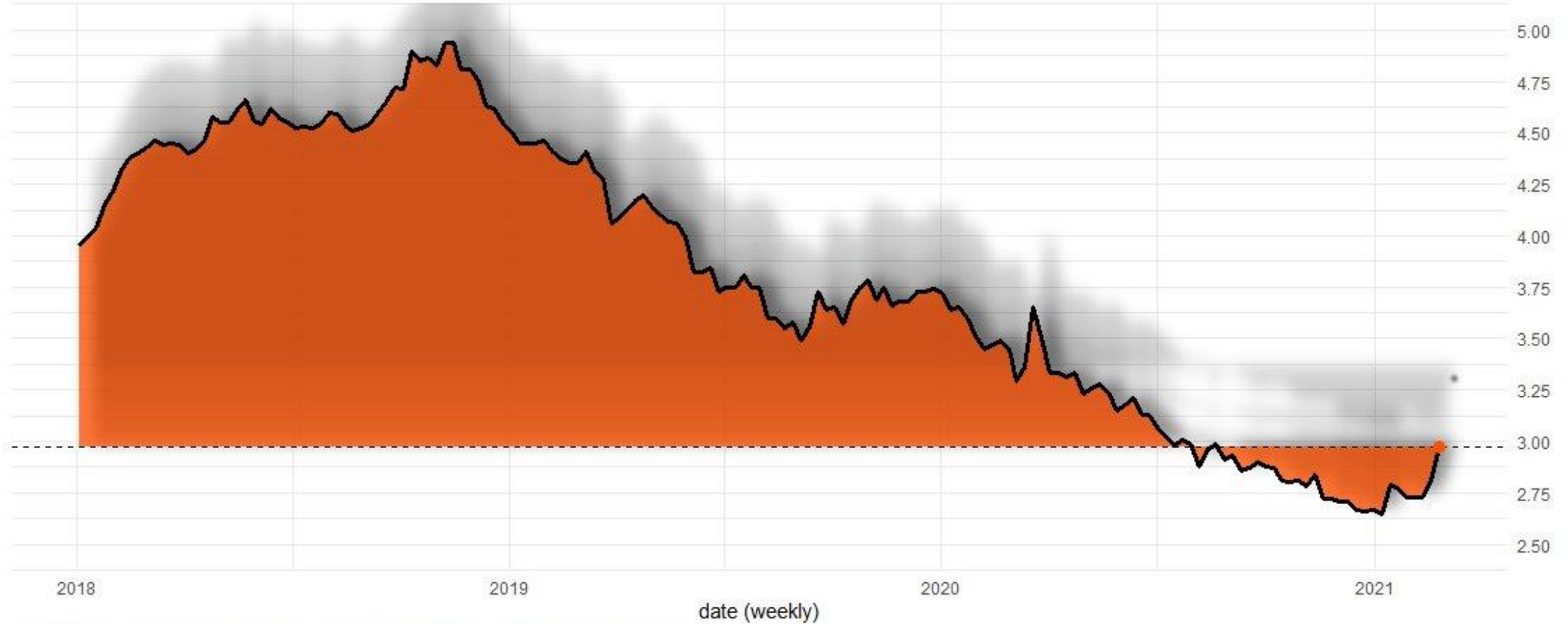
@lenkiefer Source: Freddie Mac Primary Mortgage Market Survey through February 25, 2021
dotted line at latest value

Get more information

An excellent resource:

https://clauswilke.com/dataviz/

Fundamentals of Data Visualization

Claus O. Wilke

Welcome

This is the website for the book "Fundamentals of Data Visualization," published by O'Reilly Media, Inc. The website contains the complete author manuscript before final copy-editing and other quality control. If you would like to order an official hardcopy or ebook, you can do so at various resellers, including Amazon, Barnes and Noble, Google Play, or Powells.

The book is meant as a guide to making visualizations that accurately reflect the data, tell a story, and look professional. It has grown out of my experience of working with students and postdocs in my laboratory on thousands of data visualizations. Over the years, I have noticed that the same issues arise over and over. I have attempted to collect my accumulated knowledge from these interactions in the form of this book.
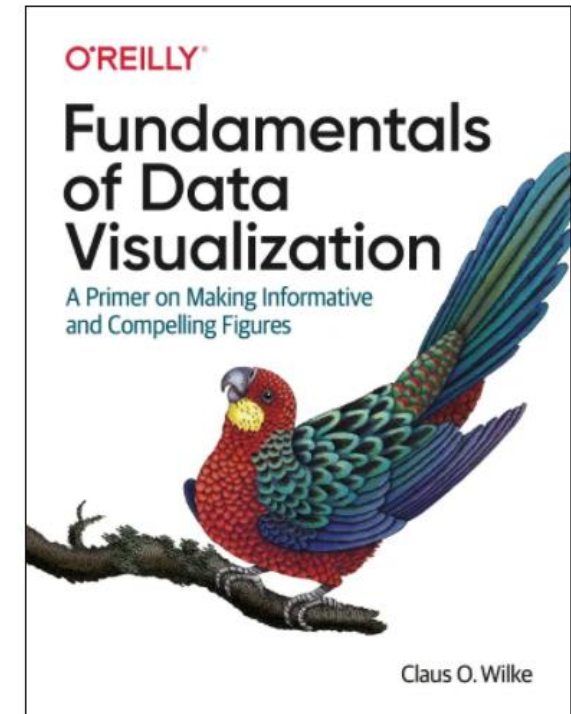
Better Data Visualizations: A Guide for Scholars, Researchers, and Wonks
By: Jonathan Schwabish

Learn about principles of visual perception and data visualization best practices.

Expand your graphic literacy by learning about more than 80 different visualization types.

Learn how to define your audience and goals, and choose the chart, graph, or diagram that best fits for your data.

https://policyviz.com/2021/02/11/inside-better-data-visualizations-a-guide-for-scholars-researchers-and-wonks/
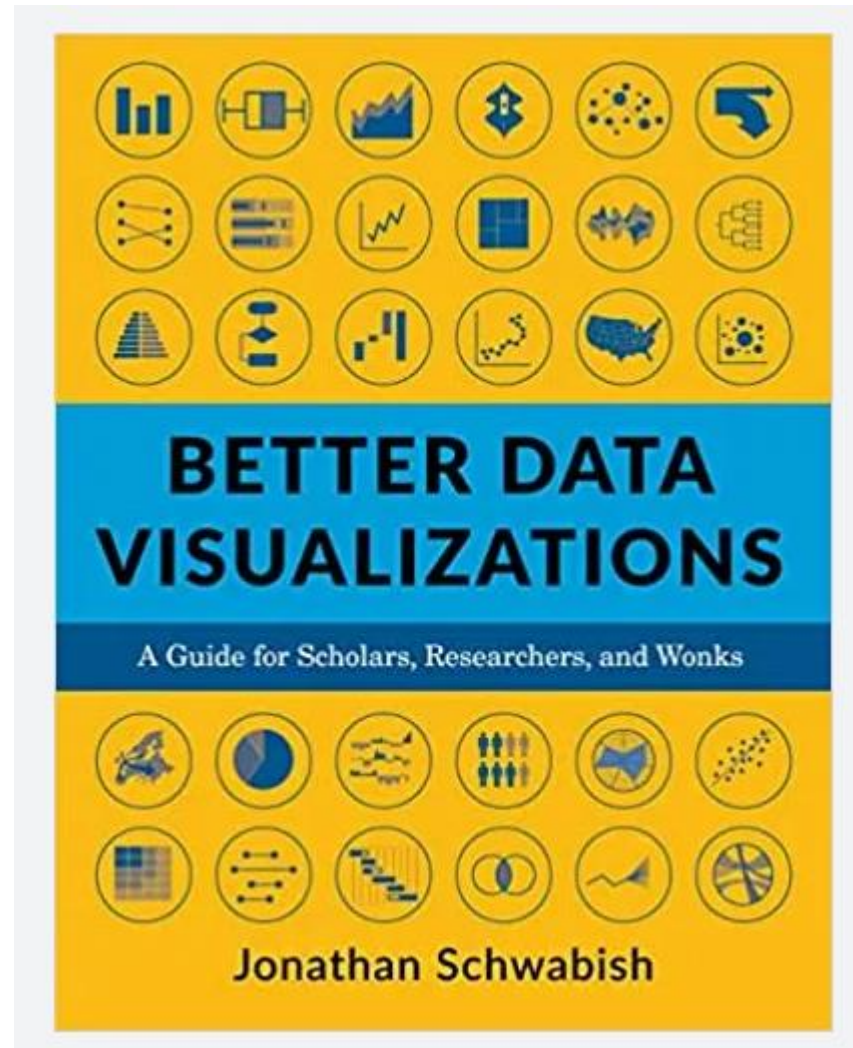
Find reproducible R code at lenkiefer.com, or follow me on Twitter and LinkedIn