Mitigating the Effects of the Covid-19 Pandemic on Seasonally Adjusted Price Indexes

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Seasonal adjustment overview

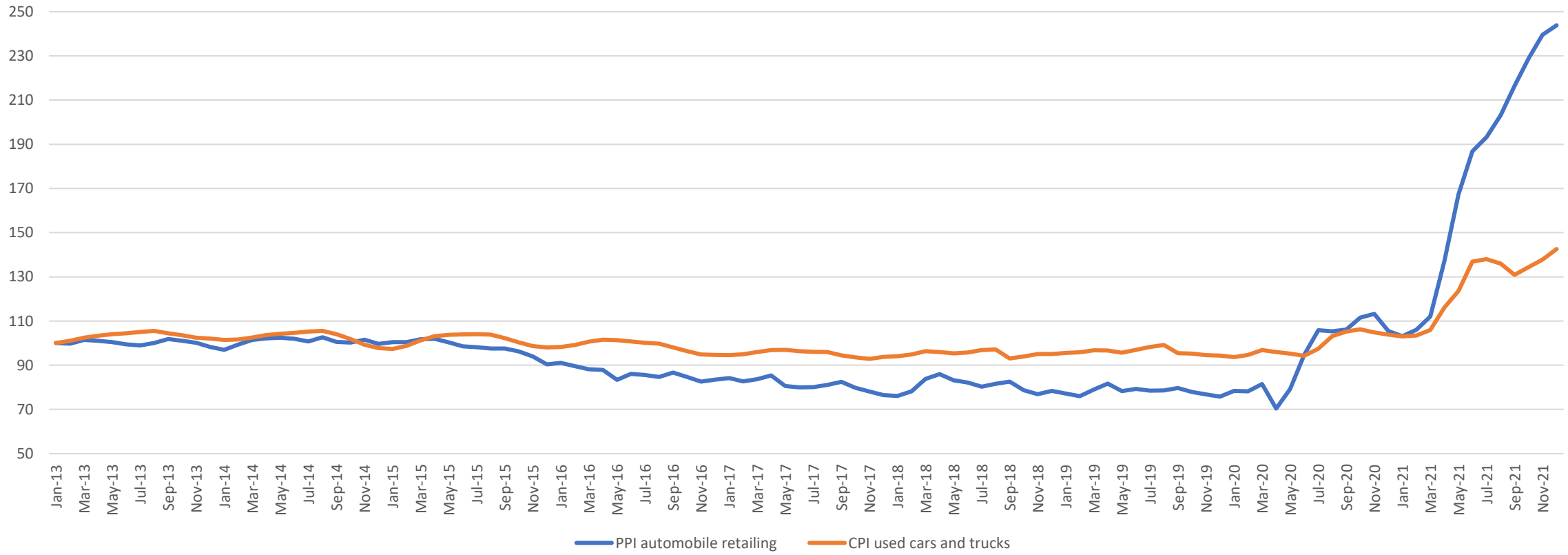
- The BLS publishes seasonally adjusted Consumer Price index (CPI) and Producer Price Index (PPI) time-series data
- Seasonal adjustment removes within-year seasonal patterns from index data
- To seasonally adjust data, CPI and PPI use the Census X-13 ARIMA-SEATS
  - a filter-based approach that employs moving averages of historical data to estimate the seasonal pattern of a time series

Seasonal adjustment- COVID

- In 2020 and 2021, a number of PPI and CPI price index series experienced extreme price movements as a result of the COVID-19 pandemic and other disruptions
  - Notable areas of extreme price movement include foods, energy, leisure and hospitality services, and automobile sales
  - Because historical data is used to estimate seasonality, the extreme price movements in 2020 and 2021 could potentially have adversely affected seasonal adjustment of their data

Automobile sales

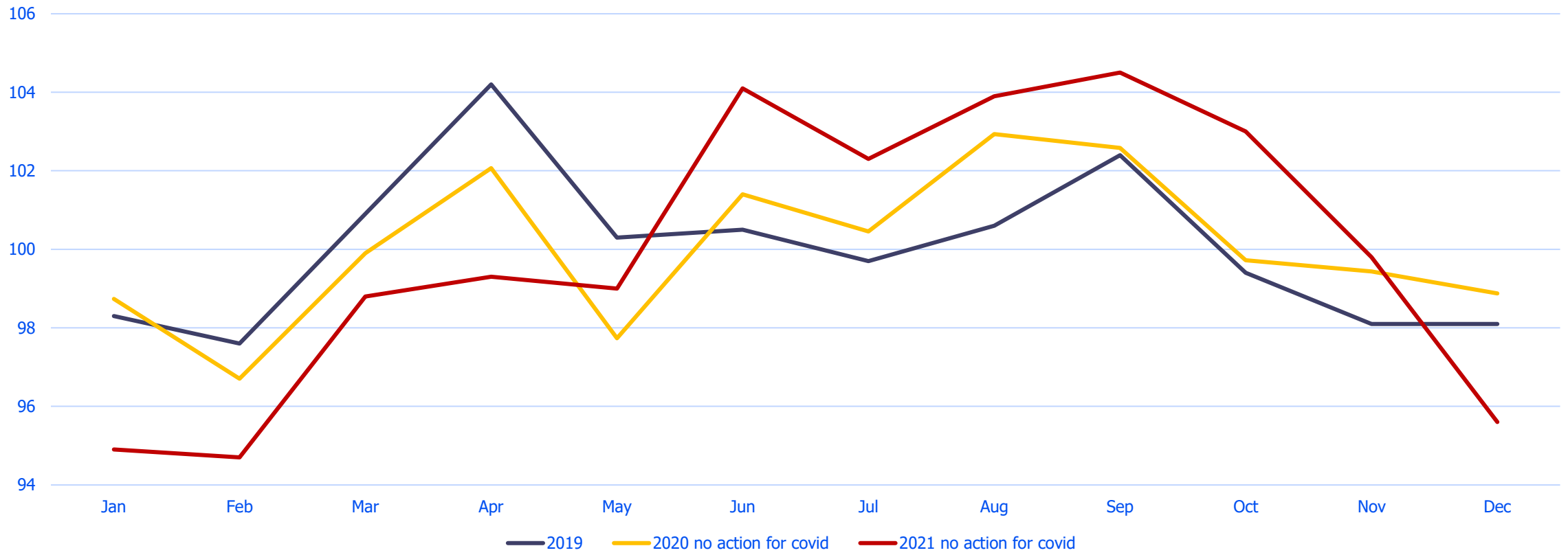
Example- Automobile sales



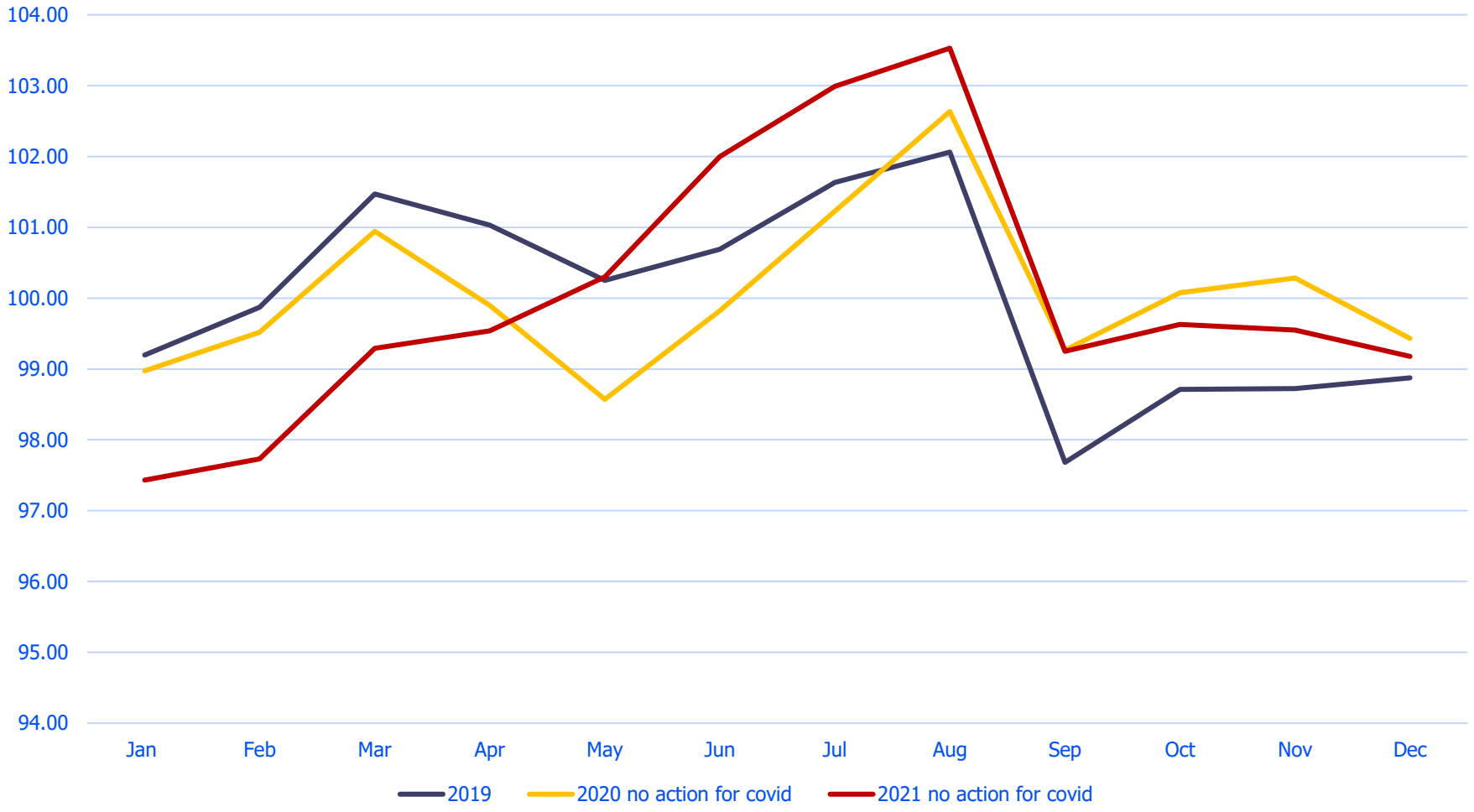
Seasonality tests- Automobile sales

QC stats automobiles	F(s)	M7	Q
PPI 2019	9.66	0.93	0.65
PPI 2020 (no COVID-19 interventions)	1.73	2.34	1.0
PPI 2021 (no COVID-19 interventions)	2.85	2.39	1.03
CPI 2019	21.74	0.52	0.48
CPI 2020 (no COVID-19 interventions)	4.41	1.54	0.91
CPI 2021 (no COVID-19 interventions)	4.02	1.58	0.92

Seasonal factors- PPI automobile retailing



Seasonal factors- CPI used cars and trucks



What can we do?

- Intervention modeling
  - Estimating and removing the effects of nonseasonal events in indexes prior to testing them for seasonality and developing seasonal factors
  - ARIMA model with variables to account for non-seasonal events
    - Outlier
    - Level shift
    - Ramp
  - X-13ARIMA-SEATS is used to model
  - After non-seasonal effects are removed, standard seasonal adjustment methods are applied and used to test for seasonality and to develop seasonal factors

Intervention modeling

2020

- PPI for automobile retailing
  - Level shift: April 2020
  - Ramp: April 2020 - July 2020
  - Outlier: November 2020
- CPI for used cars and trucks
  - Ramp: June 2020 - September 2020

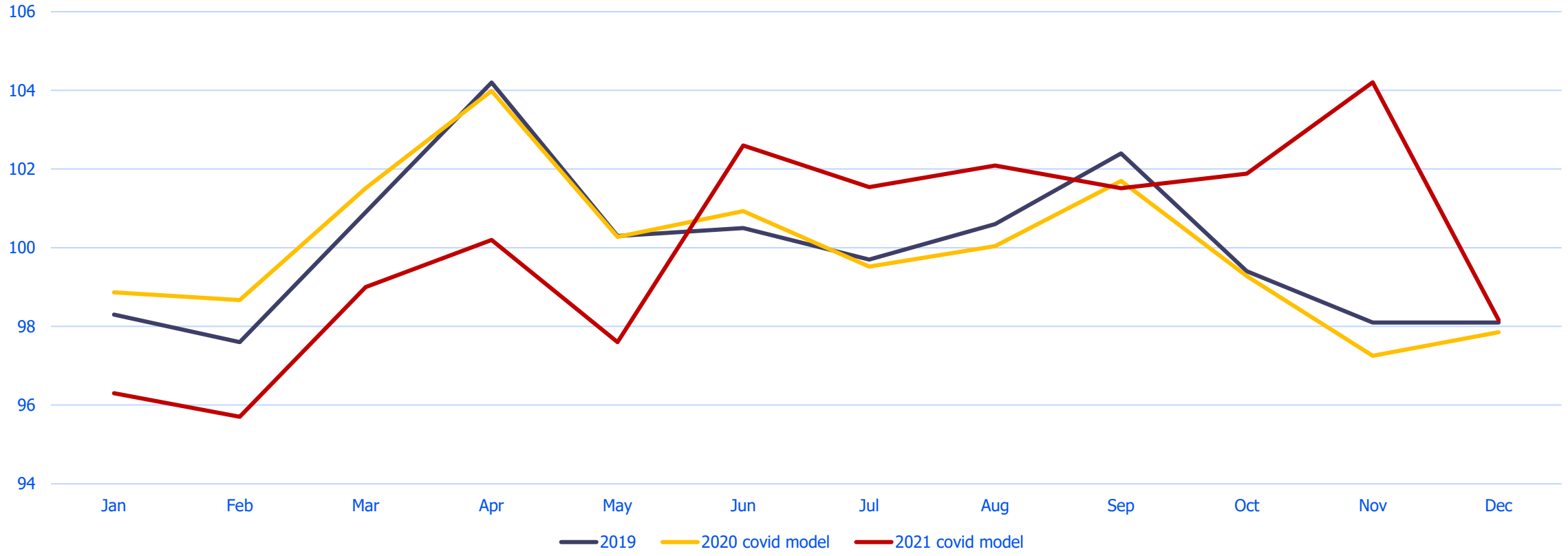
2021

- PPI for automobile retailing
  - Level shift: April 2020
  - Ramp: April 2020 - July 2020
  - Level shift: May 2021
  - Level shift: September 2021
- CPI for used cars and trucks
  - Ramp: June 2020 - September 2020
  - Ramp: March 2021 – June 2021
  - Ramp: September 2021 – December 2021
  - s3x9 filters applied

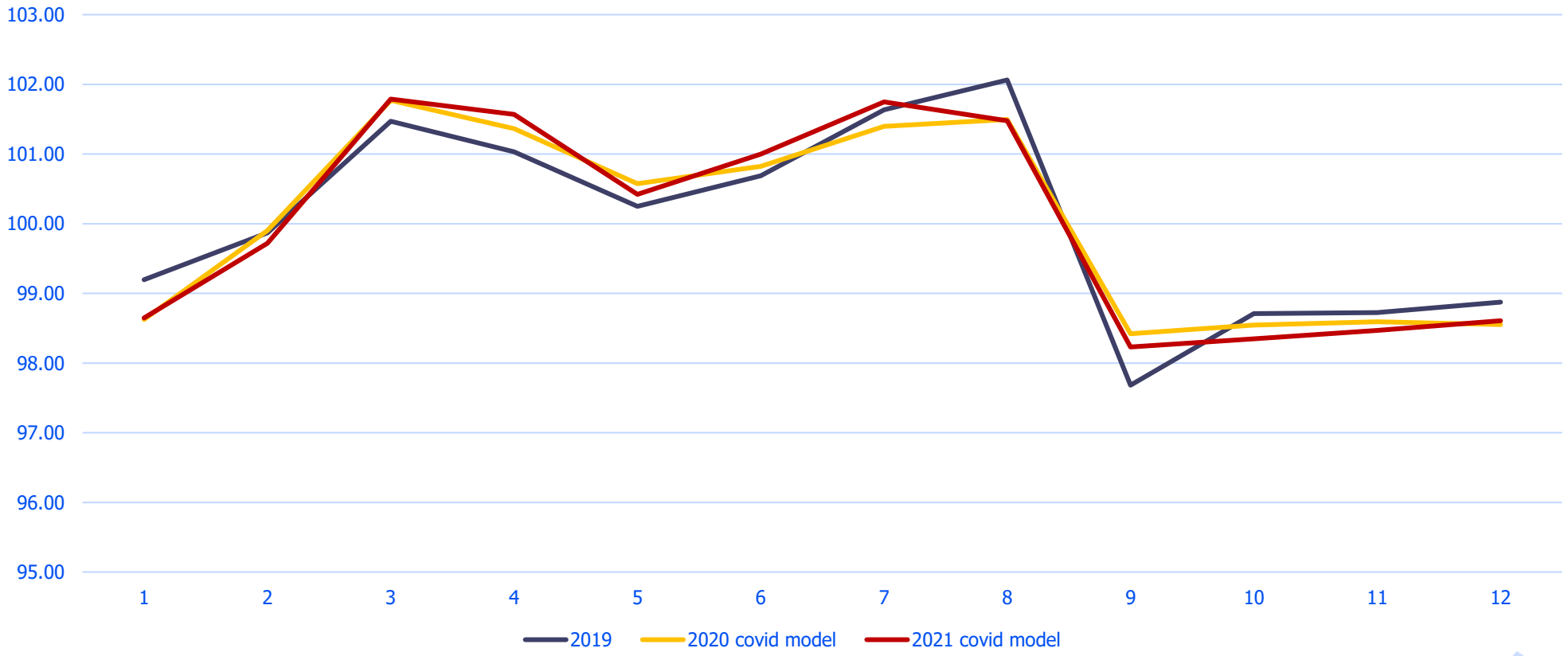
Seasonality tests- automobile sales – with intervention model

QC stats automobiles	F(s)	M7	Q
PPI 2020 after modeling	9.97	0.94	0.68
PPI 2021 after modeling	5.11	1.53	1.03
CPI 2020 after modeling	53.31	0.36	0.19
CPI 2021 after modeling	73.88	0.27	0.13

Seasonal factors- PPI automobile retailing- with intervention model

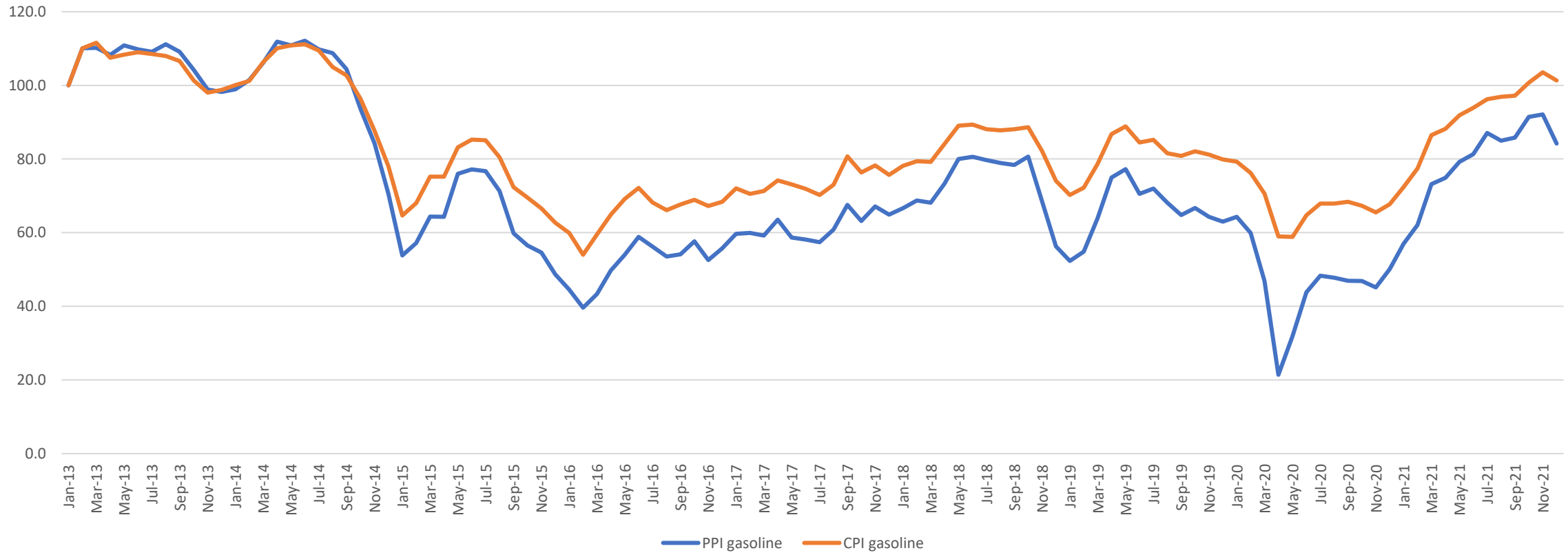


Seasonal factors- CPI used cars and trucks - with intervention model



Gasoline

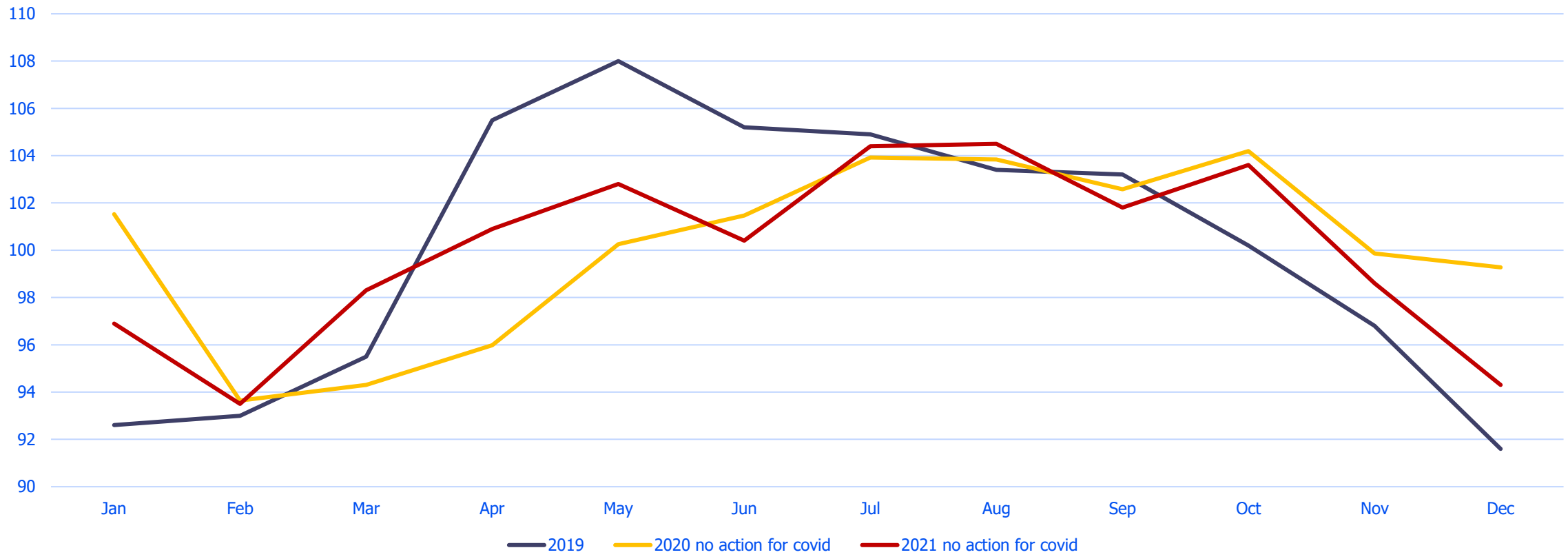
Example- Gasoline



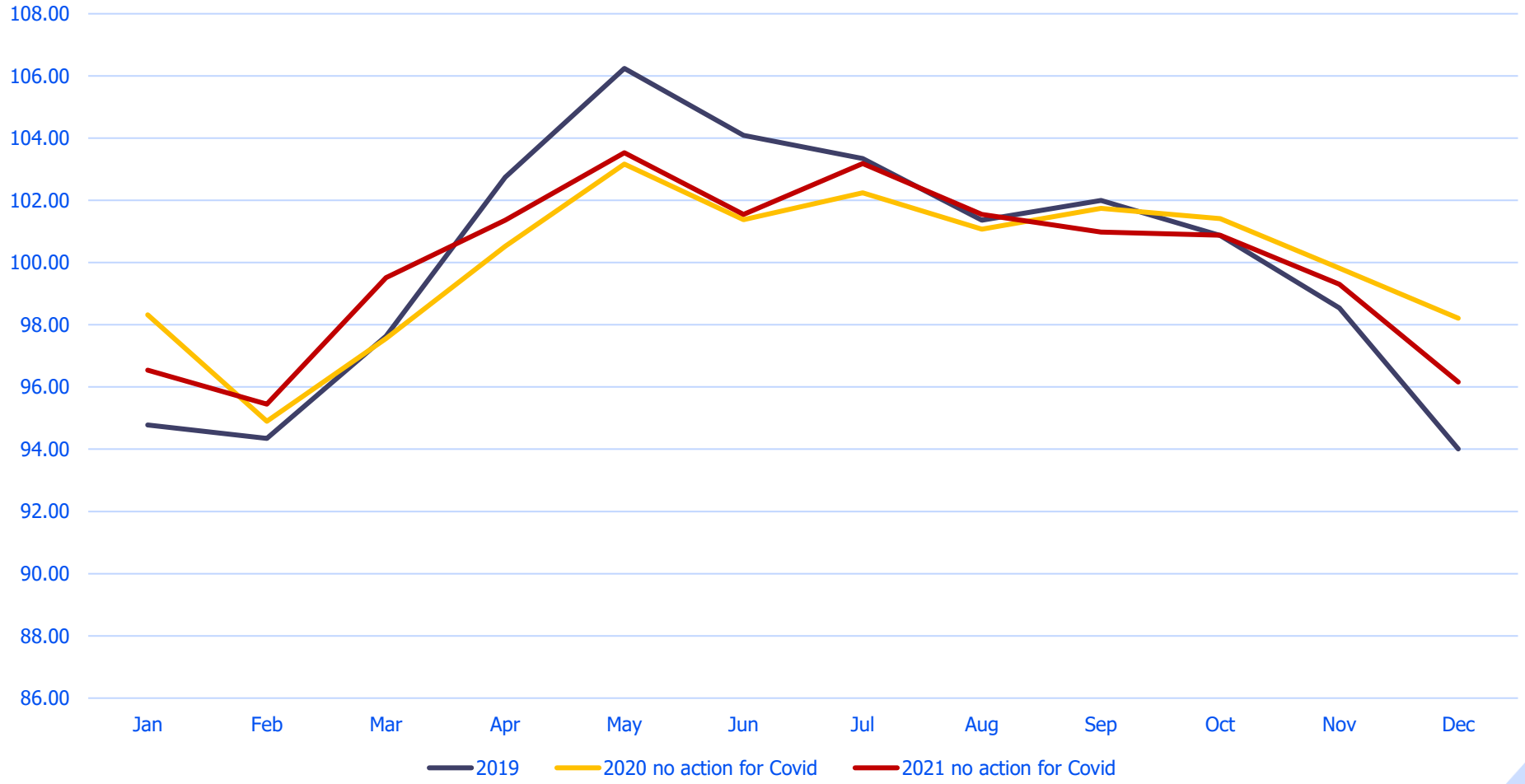
Seasonality tests- Gasoline

QC stats gasoline	F(s)	M7	Q
PPI 2019	17.84	0.58	0.64
PPI 2020 (no COVID-19 interventions)	3.1	1.39	1.02
PPI 2021 (no COVID-19 interventions)	4.35	1.28	0.89
CPI 2019	17.13	0.56	0.59
CPI 2020 (no COVID-19 interventions)	10.58	0.83	0.71
CPI 2021 (no COVID-19 interventions)	9.65	1.03	0.65

Seasonal factors- PPI gasoline



Seasonal factors- CPI gasoline



Intervention modeling

2020

- PPI for gasoline
  - Ramp: Nov 2014-January 2015
  - Level shift: November 2015
  - Ramp: February 2020- April 2020
  - Ramp: April 2020 - July 2020
- CPI for gasoline
  - Ramp: Nov 2014-January 2015
  - Level shift: April 2020
  - Stable seasonality applied

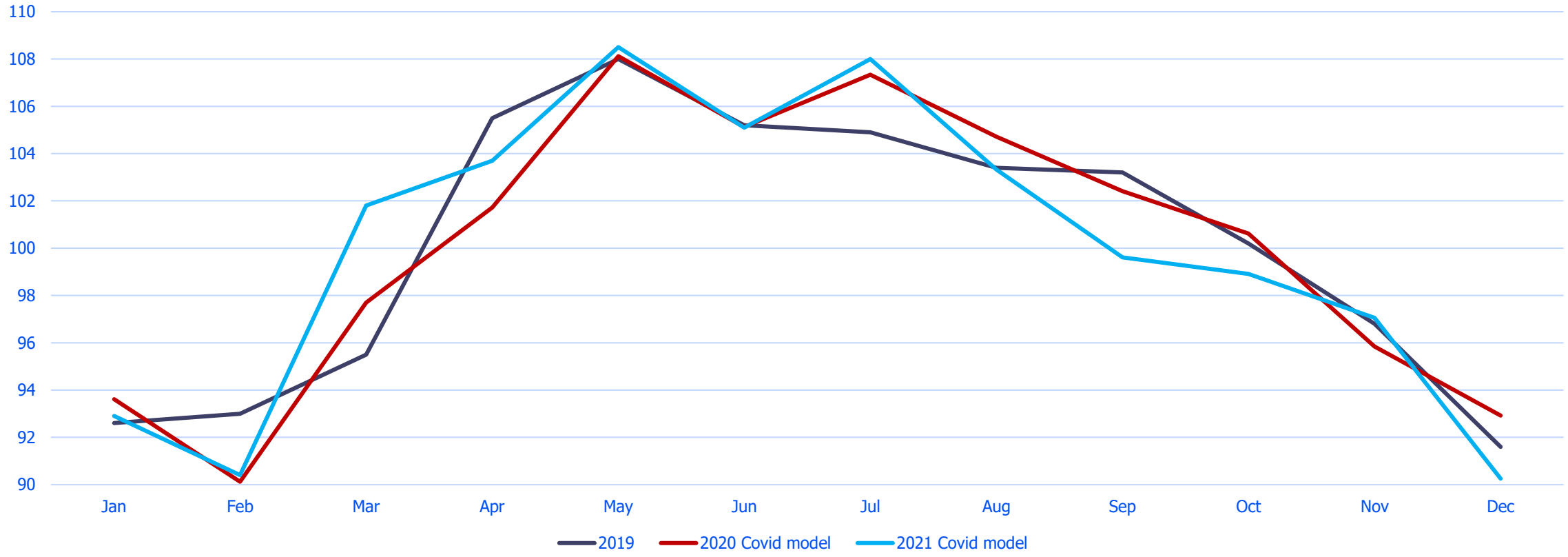
2021

- PPI for gasoline
  - Ramp: Nov 2014-January 2015
  - Level shift: November 2015
  - Ramp: February 2020- April 2020
  - Ramp: April 2020 - July 2020
- CPI for gasoline
  - Ramp: Nov 2014-January 2015
  - Level shift: April 2020
  - S3x9 filters applied

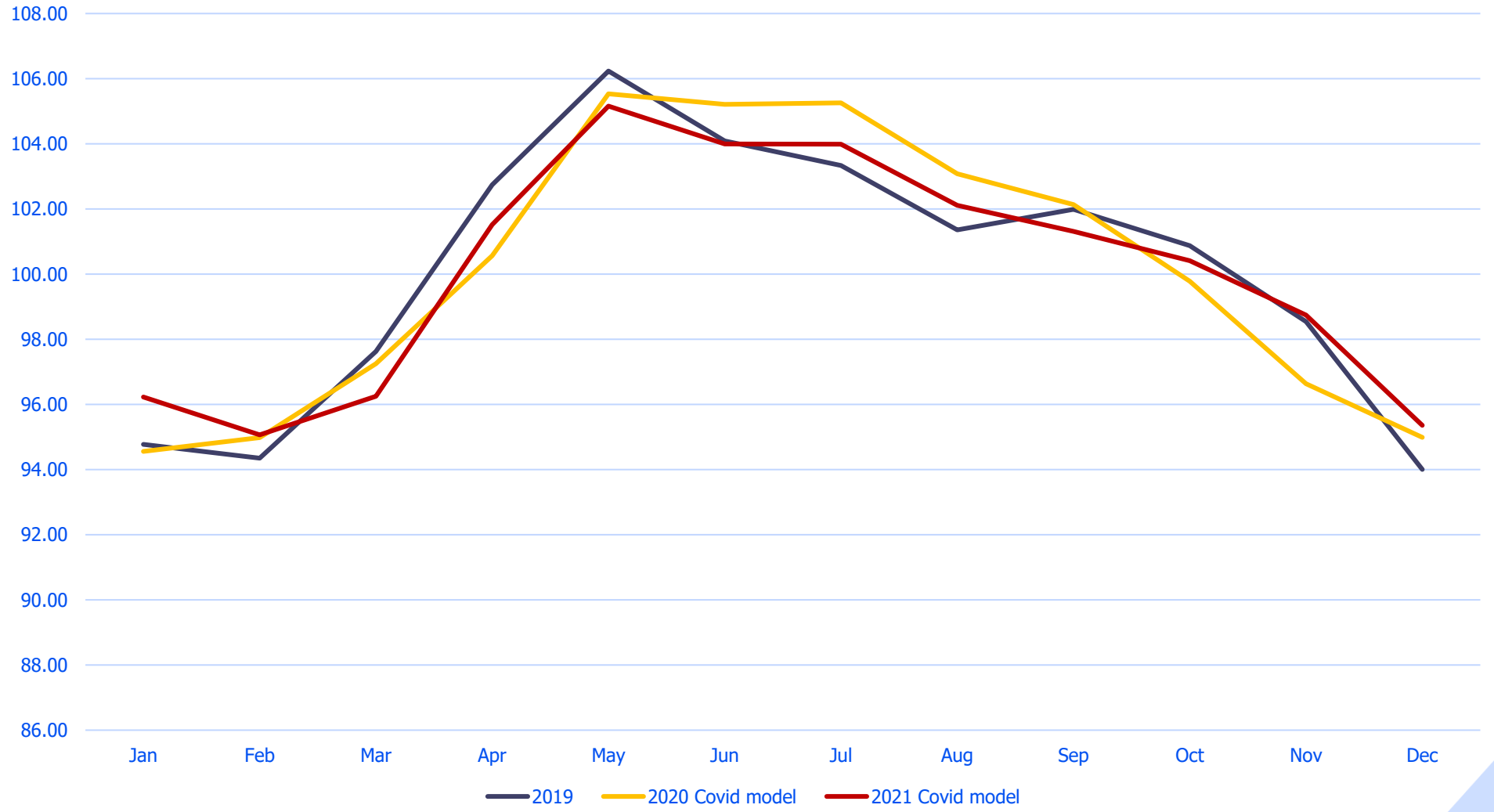
Seasonality tests- gasoline – with intervention model

QC stats gasoline	F(s)	M7	Q
PPI 2020 after modeling	17.84	0.58	0.64
PPI 2021 after modeling	13.65	0.71	0.62
CPI 2020 after modeling	18.11	0.51	0.73
CPI 2021 after modeling	14.92	0.64	0.55

Seasonal factors- PPI gasoline- with intervention model



Seasonal factors- CPI gasoline - with intervention model



Intervention modeling scope in 2020 and 2021

- For each series that was seasonally adjusted in 2019
  - Visually examined for extreme price movements
  - QC statistics 2013-2020 vs 2012-2019 (2014-2021 vs 2013-2020)
  - Seasonal factors 2013-2020 vs 2012-2019 (2014-2021 vs 2013-2020)
  - Automatic outlier detection
  - Consulting with expert industry and commodity analysts

Intervention modeling scope in 2020 and 2021

- COVID-19 pandemic was deemed to negatively affect seasonal adjustment when some combination occurred:
  - Extreme price movements in 2020 and 2021
  - QC stats changed substantially with COVID-19 period data
  - Seasonal factors changed substantially with COVID-19 period data
  - Auto outlier detected points in 2020 and 2021
  - Analysts indicated that COVID-19 was affecting the time series
- Series was then included as an intervention series for 2020 and 2021

Intervention modeling scope in 2020 and 2021

- CPI
  - Intervention analysis conducted on 70 indexes in 2021
    - Of the 70 series, 52 series contained only intervention points in 2020 and 2021
  - Intervention analysis conducted on 68 indexes in 2020
    - Of the 68 series, 47 series were added strictly to mitigate COVID effects on seasonal adjustment in 2020
  - Intervention analysis conducted on 32 indexes in 2019
  - Total number of interventions increased about 112.5 percent from 2019 to 2020

Intervention modeling scope in 2020

- PPI
  - Intervention analysis was conducted on 76 series in 2021
    - Of the 76 series, 36 series were added strictly to mitigate COVID effects on seasonal adjustment
  - Intervention analysis was conducted on 76 series in 2020
    - Of the 76 series, 36 series were added strictly to mitigate COVID effects on seasonal adjustment
  - Intervention analysis was conducted compared to 41 in 2019
  - Total number of interventions for PPI increased 64 percent from 2019 to 2020

Historical index revisions

Average monthly revision:	PPI final demand	CPI all items
2017	0.075	0.055
2018	0.046	0.058
2019	0.058	0.046
2020	0.042	0.059
2021	0.058	0.056

Seasonality of Aggregates (CPI)

- All items

Year	F(s)	M7	Q
2021	19.999	0.751	0.55
2020	16.953	0.839	0.67
2019	43.449	0.45	0.39
2018	37.908	0.467	0.33
2017	36.128	0.452	0.4
2016	35.433	0.398	0.37

- All items less food and energy

Year	F(s)	M7	Q
2021	8.477	0.841	0.57
2020	11.440	0.785	0.55
2019	66.835	0.294	0.26
2018	68.969	0.308	0.27
2017	68.969	0.308	0.27
2016	88.637	0.277	0.26

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Bureau of Labor Statistics
Producer Price Index
Consumer Price Index