Seasonal Adjustment With X-13ARIMA-SEATS

2019

Economic Statistical Methods Division

U.S. Census Bureau

United States Census Bureau

U.S. Department of Commerce
Economics and Statistics Administration
U.S. CENSUS BUREAU
census.gov

Course Instructors

James Livsey

james.a.livsey@census.gov

Center for Statistical Research and Methodology

U.S. Census Bureau

Demetra Lytras

demetra.p.Lytras@census.gov

Economic Statistical Methods Division

U.S. Census Bureau

Goals of Course

Provide *working, practical* information on

- Time series models
- Seasonal adjustment with the X-11 and SEATS methods
- Diagnostics
  - Modeling
  - Seasonal adjustment
- X-13ARIMA-SEATS spec file general syntax

Perspective of Course

- Primary Goal: Help with setting up seasonal adjustment, selecting adjustment options, comparing diagnostics
- Secondary Goal: Provide guidance for production situations

Outline

- Introduction to Time Series
- Overview of X-13ARIMA-SEATS
- RegARIMA Modeling and Diagnostics
- Generating User Holiday Effects with Genhol
- Introduction to Seasonal Adjustment
- Moving Average Filters
- X-11 Seasonal Adjustment Method
- SEATS Seasonal Adjustment Method
- Seasonal Adjustment Diagnostics
- Composite Adjustments
- Final Thoughts

Introduction to Time Series

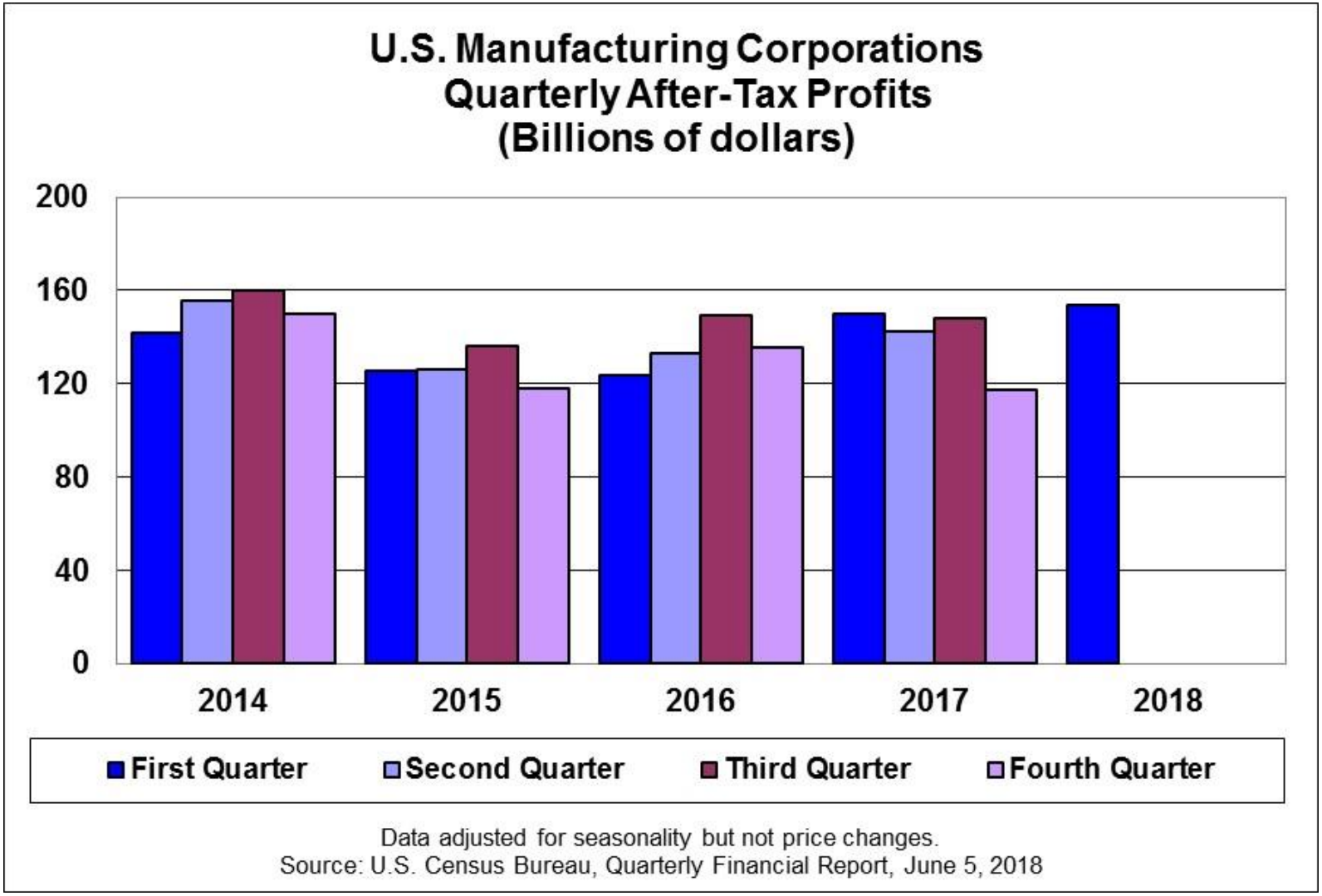
What Is a Time Series?

Working Definition:

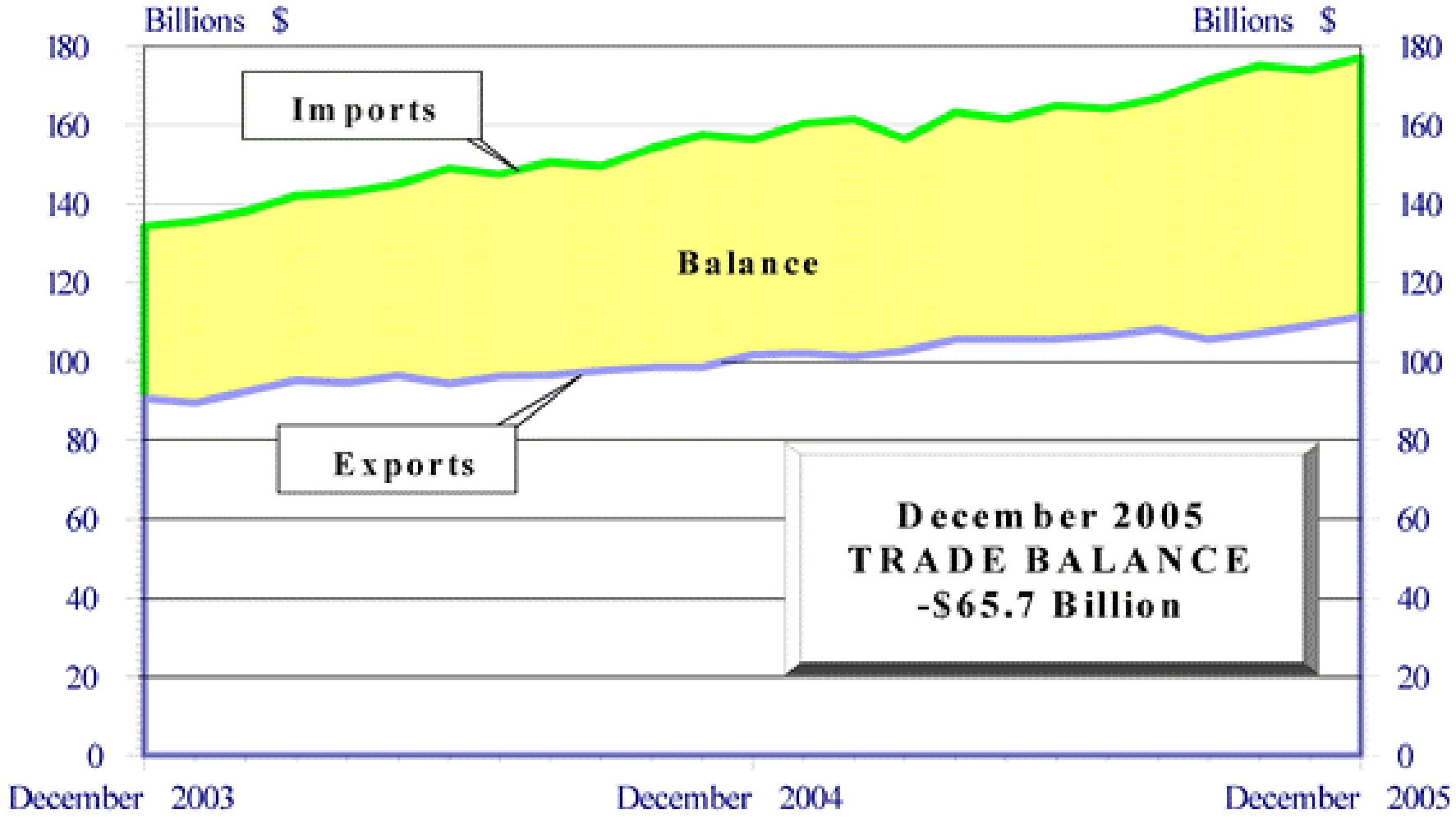
A sequence of repeated measurements of the same concept over regular, consecutive time intervals (often monthly, quarterly, annually)

Time Series? Dow Jones Industrial Average

Source: Google search on “dow jones chart” (without quotation marks)


U.S. Manufacturing Corporations
Quarterly After-Tax Profits
(Billions of dollars)
200
160
120
80
40
0
2014
2015
2016
2017
2018
First Quarter
Second Quarter
Third Quarter
Fourth Quarter
Data adjusted for seasonality but not price changes.
Source: U.S. Census Bureau, Quarterly Financial Report, June 5, 2018

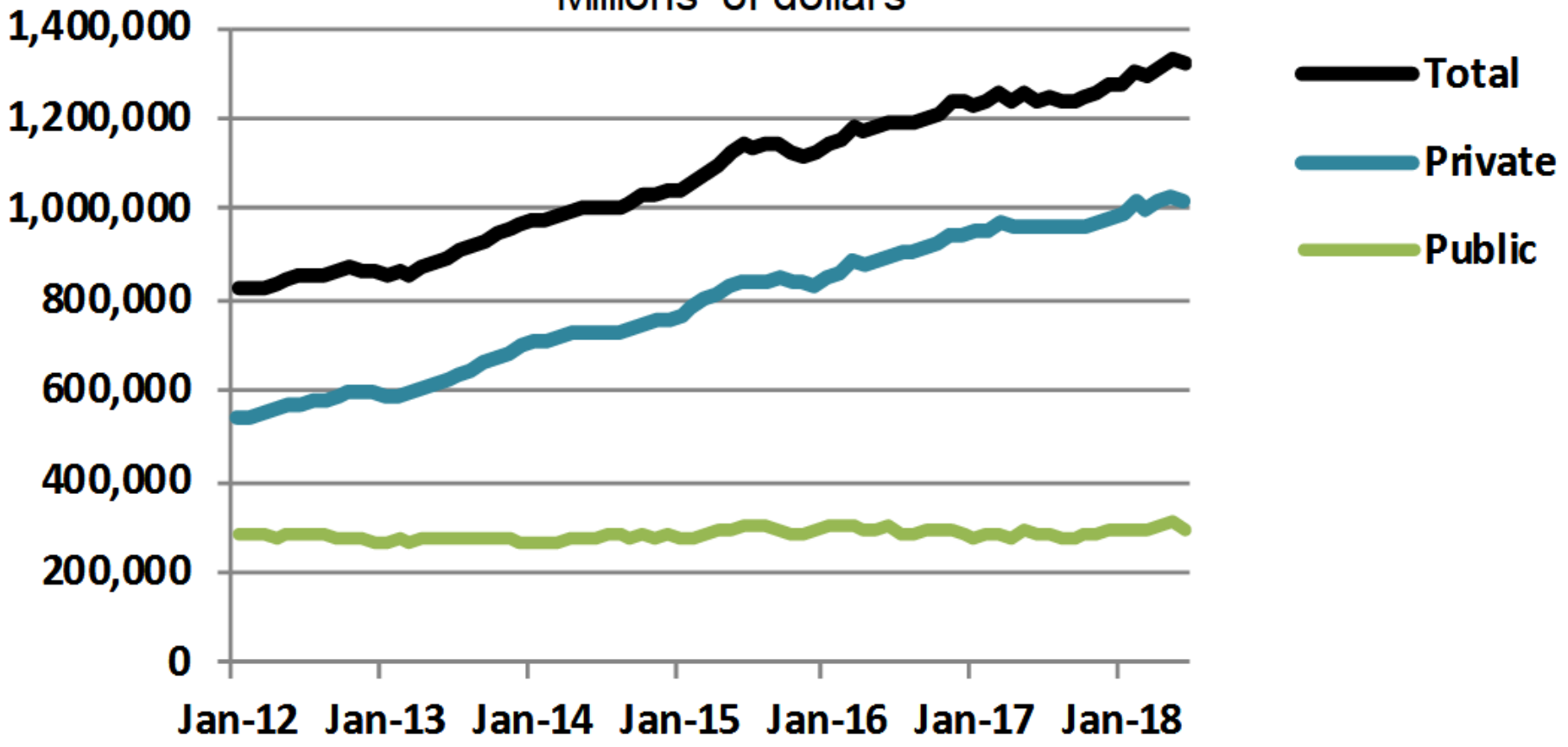
U.S. International Trade in Goods and Services



Construction Spending

(Seasonally Adjusted Annual Rate)

Millions of dollars



Source: U.S. Census Bureau, August 1, 2018.

Importance of Time Series

- The Census Bureau produces estimates of more than 1,000 time series every month
- Economists, policy makers, and consumers use the published time series to make decisions

Characteristics Needed for Analyzing Time Series

- Consistency
  - Estimates must be comparable over time – consistent in concept and measurement
- Uniform measurement periods
  - Every month/quarter (or measured annually at the same time each year)
    - We have methods for adjusting for the length of month or quarter

Why Look at Data Over Time?

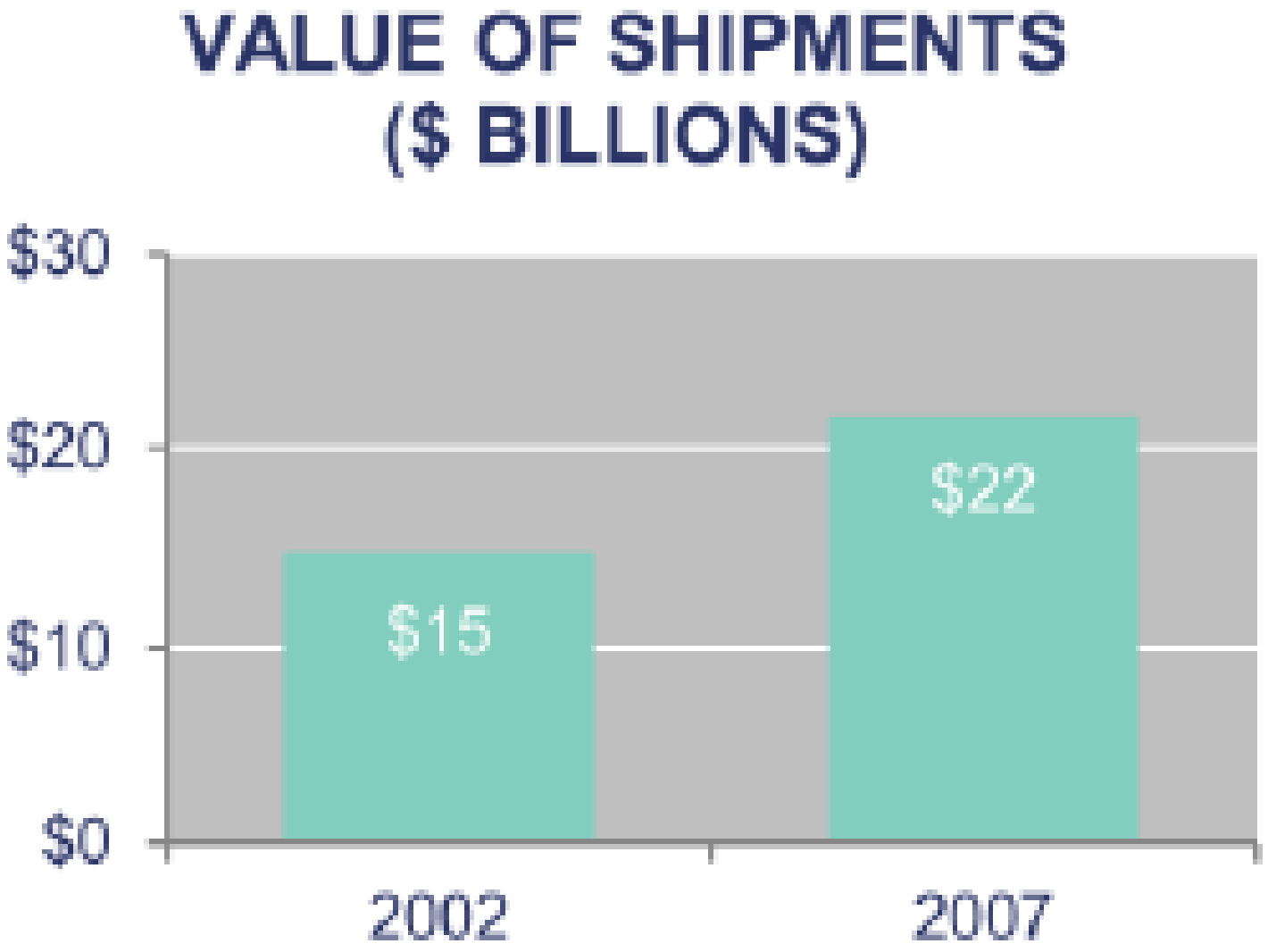
- Look for patterns and changes
- Example: Economic Census, Farm Machinery and Equipment Manufacturing (NAICS 333111)

Source: U.S. Census Bureau

Note: The Census Bureau provides guidance on comparing historical data and warns about changes to scope, definition, etc.

Farm Machinery and Equipment Manufacturing

	2002	2007	% Change
Number of establishments	1,214	1,153	-5.0%
Value of shipments ($ Millions)	14,693	21,729	47.9%
Annual payroll ($ Millions)	2,088	2,413	15.6%
Total employment	53,817	54,713	1.7%


VALUE OF SHIPMENTS
($ BILLIONS)
$30
$20
$10
$0
$15
$22
2002
2007

How Are Time Series Data Different From Other Data?

- Data are not independent (correlation)
  - Much statistical theory relies on data that are independent and identically distributed
  - Patterns = not independent
- Large samples sizes are good, but long time series are not always best
  - Time series features often change with time, so bigger samples (longer series) are not always better for analysis

Major Time Series Software Developed at the Census Bureau

- X-13ARIMA-SEATS (X-13A-S)
  - Fortran program that performs the seasonal adjustment
- Win X-13
  - C# Windows interface to X-13A-S (with SAS or Java graphs)
- X-13-Graph
  - SAS and Java versions; graph results from X-13A-S graphics files

Census Bureau Time Series Software, Continued

- Genhol & Win Genhol
  - Creates moving holiday regressors from a list of holiday dates
- X-13-Data
  - Windows interface to convert Excel data into text files that X-13A-S can read
- X-13-SAM
  - Edits multiple spec files at once

Non-Census Seasonal Adjustment Software

- R seasonal package
  - An interface that directly runs X-13A-S in R
  - Developed by Christoph Sax
- TRAMO/SEATS
  - Time series modeling and seasonal adjustment software (Fortran)
  - Developed by the Bank of Spain
- JDemetra+
  - EuroStat's seasonal adjustment program; rewrote much of X-13ARIMA-SEATS and TRAMO/SEATS in Java

X-13ARIMA-SEATS

- Seasonal Adjustment program developed at the Census Bureau
  - Time series modeling, forecasting
- Follows
  - X-11 (Census Bureau)
  - X-11-ARIMA, X-11-ARIMA/88, X-11-ARIMA/2000 (Statistics Canada)
  - X-12-ARIMA (Census Bureau)

X-13ARIMA-SEATS – note

- First released in summer 2012
- Includes everything previous program had
  - Plus model-based seasonal adjustment

X-13ARIMA-SEATS Components

- RegARIMA = Regression + ARIMA
  - Prior-adjusts the series before seasonal adjustment
  - Extends the series with forecasts
  - ARIMA = Autoregressive Integrated Moving Average
- X-11
  - Seasonally adjusts the series
- SEATS
  - Seasonally adjusts the series