

A Plan for Examining Signal Extraction of the Manufacturers' Shipments, Inventories, and Orders (M3) Survey

Seasonal Adjustment Practitioners Workshop

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Disclaimer

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The Census Bureau has reviewed the data product for unauthorized disclosure of confidential information.

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Outline

- Motivation
- M3 survey overview
- Current seasonal adjustment methods (X-11)
- Research plan
- SEATS (Signal extraction in ARIMA time series)
- Multivariate signal extraction methodology

Motivation

- Explore modern signal extraction techniques
 - SEATS (Signal extraction in ARIMA time series)
 - Multivariate signal extraction with latent component models
- Improve adjustments of aggregate series
- Reduce variation and revisions and improve stability of adjustments

M3 survey overview

- The M3 survey is a monthly indicator survey that provides data on economic conditions in the domestic manufacturing sector.
- The survey sample is a non-probability panel and estimates are obtained using a link-relative procedure to produce estimates of change from benchmarked totals.
- Data are collected and tabulated predominantly by 6-digit North American Industry Classification System (NAICS).
- Statistics are provided on manufacturers' value of shipments, new orders, unfilled orders, total inventories, and inventory stages of fabrication.
- Data are released through two press releases per month, an advanced report on durable goods and a full report on nondurable goods and revised durable goods.

https://www.census.gov/manufacturing/m3/index.html

The screenshot shows the US Census Bureau website for the Manufacturers' Shipments, Inventories, & Orders (M3) survey. The page features a navigation menu with options like 'Main', 'About the Surveys', 'Get Forms', 'Historical Data', 'How the Data are Collected', 'Definitions', and 'FAQs'. The main content area is divided into sections: 'Overview' (describing the M3 survey), 'Advance Report Highlights' (for the September 2019 report), 'Full Report Highlights' (for the September 2019 full report), and 'Benchmark Reports Highlights' (for reports released in May 2018). Each highlights section includes dropdown menus for 'PDF Selection Menu' and 'Excel Selection Menu'. A right-hand sidebar contains 'Announcements' (including the FRED Mobile App and New Time Series) and a 'Release Schedule' section. The footer includes the US Census Bureau logo and the text 'U.S. Dept. of Economic U.S. CENS census.gov'.

Current Seasonal Adjustment Methods

- Flow (shipments) and stock (inventories and unfilled orders) series
- X-13ARIMA-SEATS software and X-11 adjustment method
- Concurrent adjustment, models reviewed annually
- Trading day regressors (some series)
- Adjustment performed at finest levels of detail
- Additionally, indirect adjustments published after aggregation

Example of Published M3 Aggregate Series

MVP MOTOR VEHICLES AND PARTS

36A Automobile manufacturing

36B Light truck and utility vehicle manufacturing

36C Heavy duty truck manufacturing

36D Motor vehicle body and trailer manufacturing

36E Motor vehicle parts manufacturing

BTP MOTOR VEHICLE BODIES, TRAILERS AND PARTS

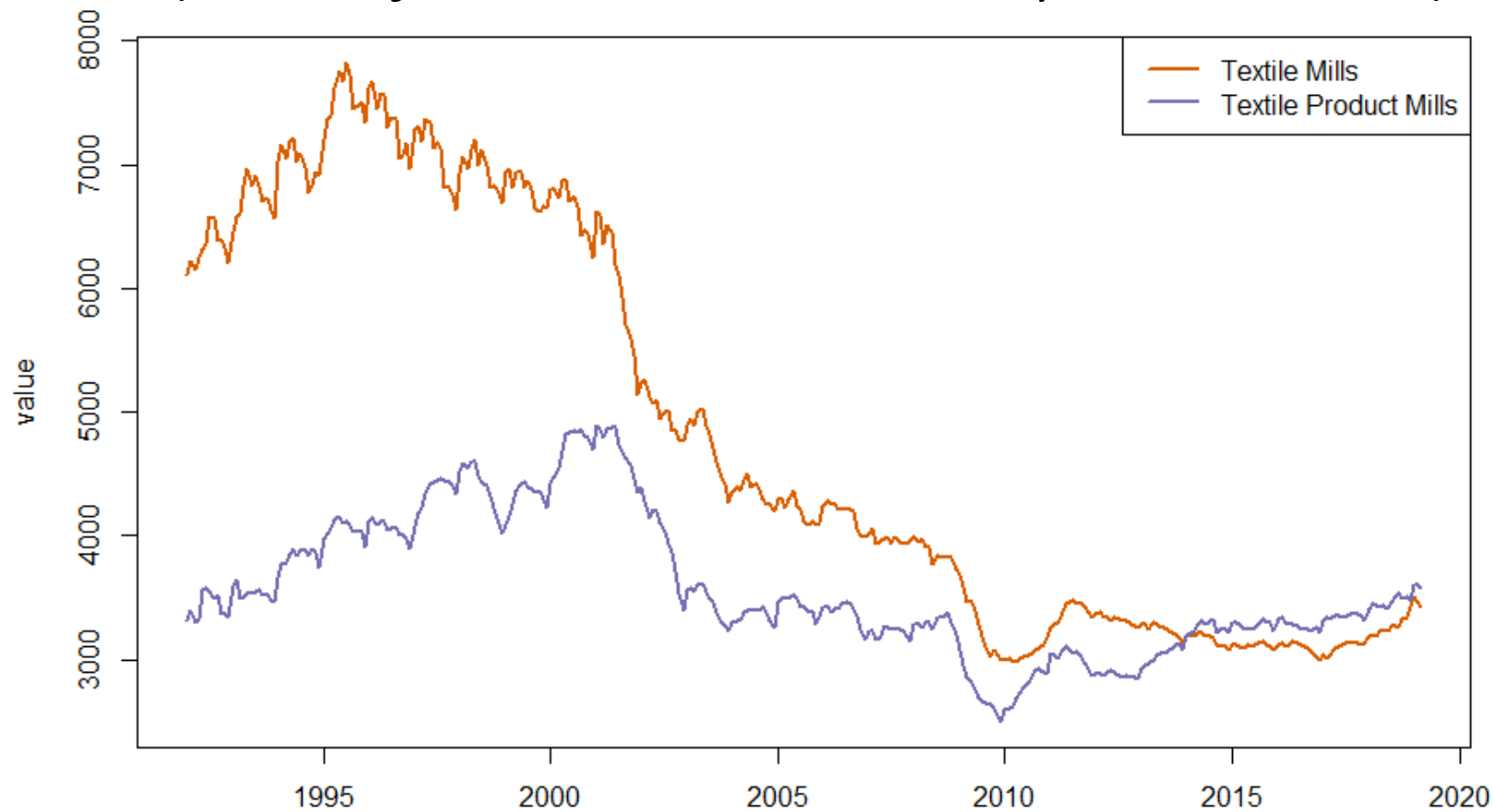
36D Motor vehicle body and trailer manufacturing

36E Motor vehicle parts manufacturing

Research Plan

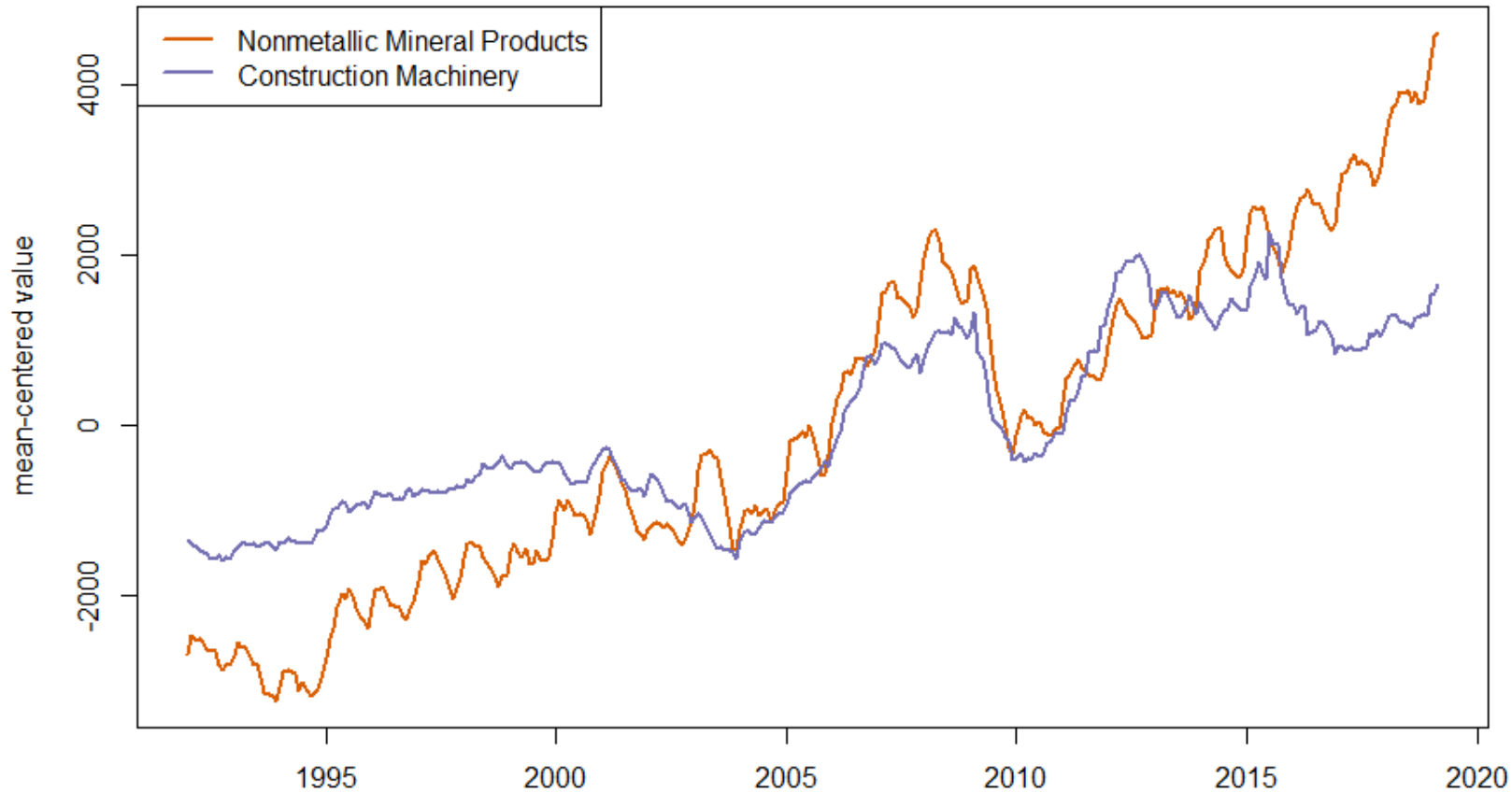
- Explore univariate models using SEATS methodology, a model-based signal extraction paradigm
- View M3 aggregate series jointly by the lower level composition series using multivariate signal extraction methodology
- Compare and contrast seasonally adjusted estimates and components versus current X-11 methodology
 - Revisions
 - Filter weights
 - Other?

Inventories in Millions of Dollars (not adjusted for seasonality or inflation)



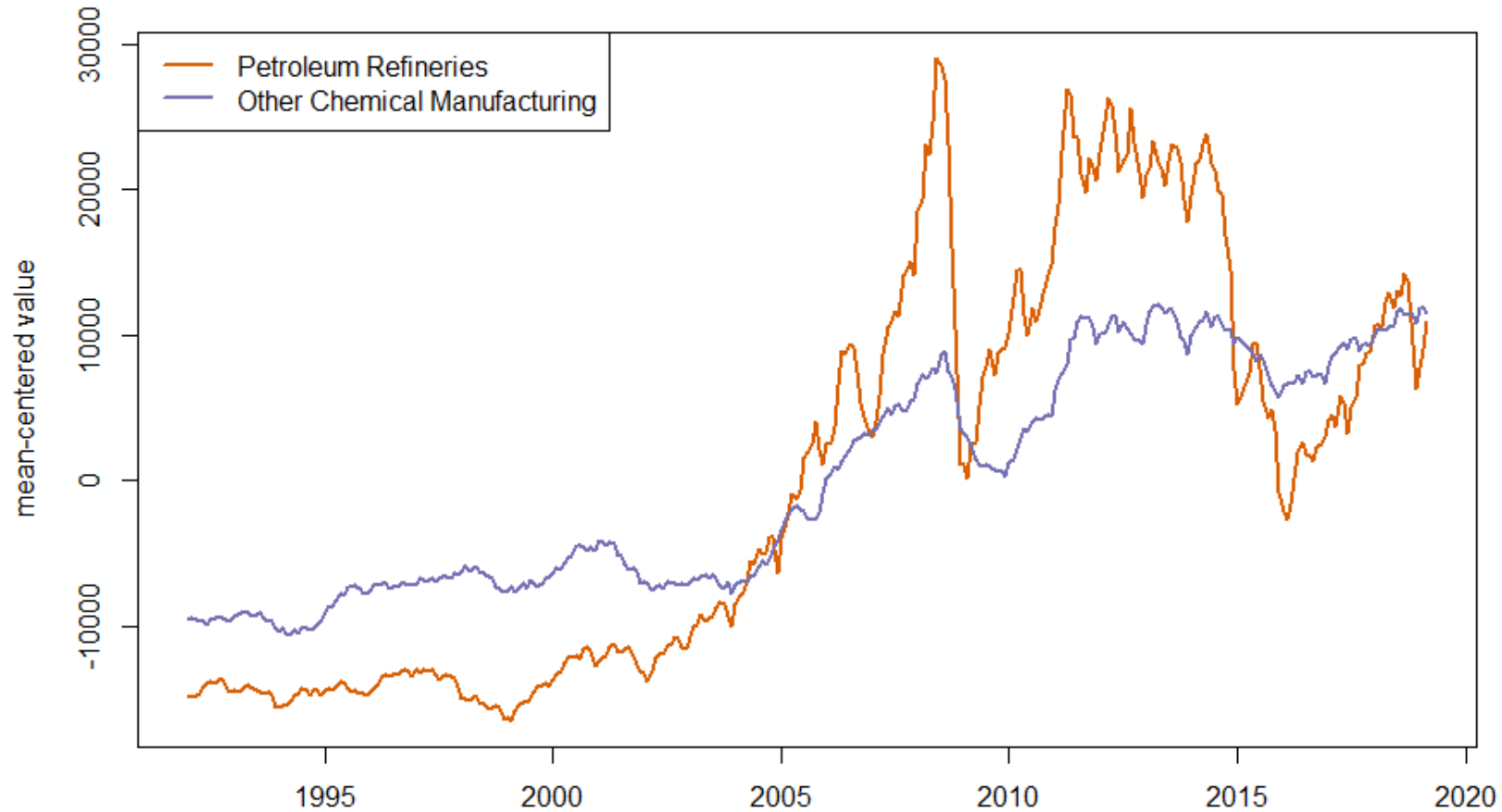
Source: U.S. Census Bureau, Manufacturers' Shipments Inventories, and Orders, <www.census.gov/manufacturing/m3/index.html>

Inventories in Millions of Dollars (not adjusted for seasonality or inflation)



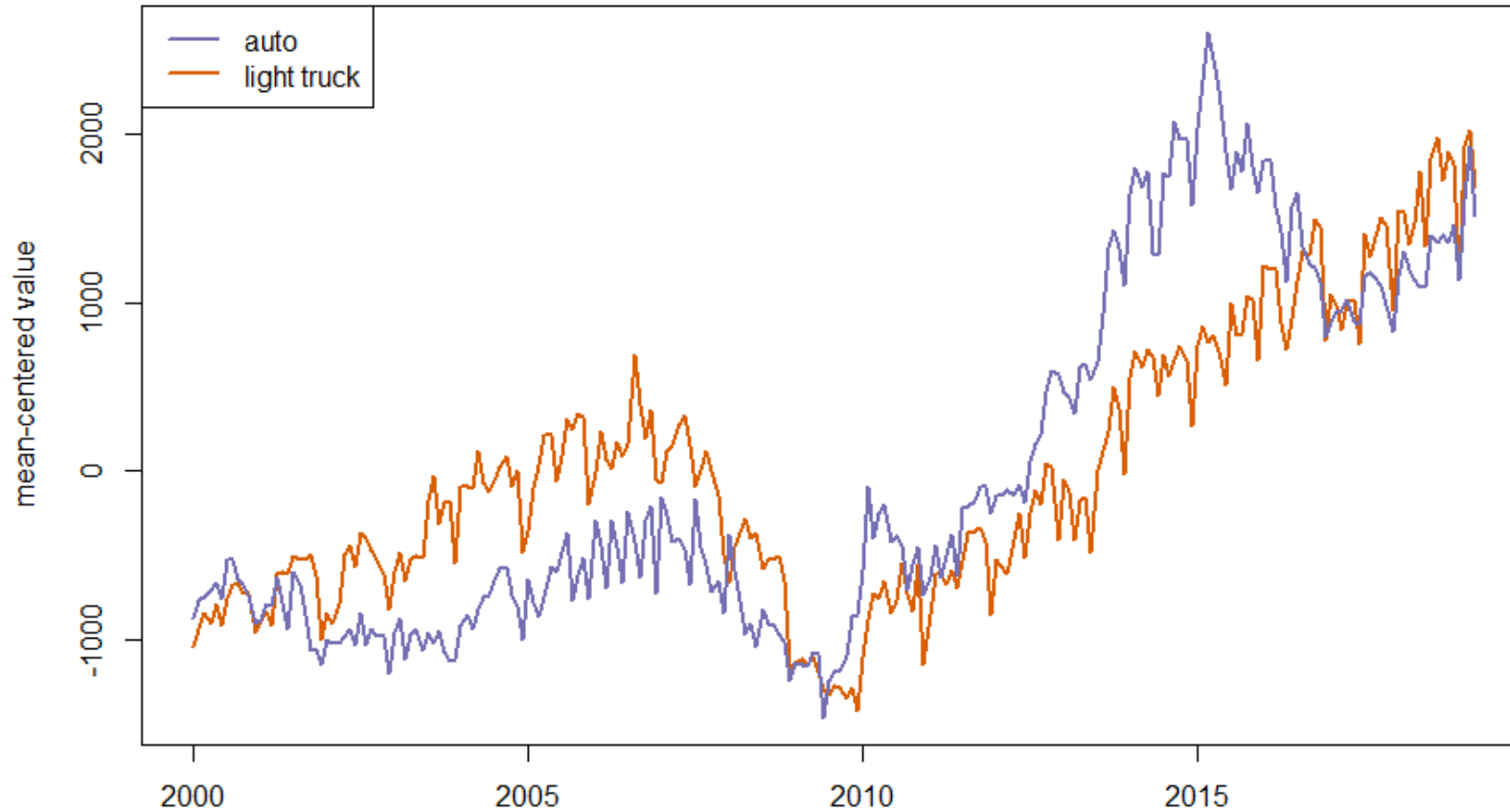
Source: U.S. Census Bureau, Manufacturers' Shipments Inventories, and Orders, <www.census.gov/manufacturing/m3/index.html>

Inventories in Millions of Dollars (not adjusted for seasonality or inflation)



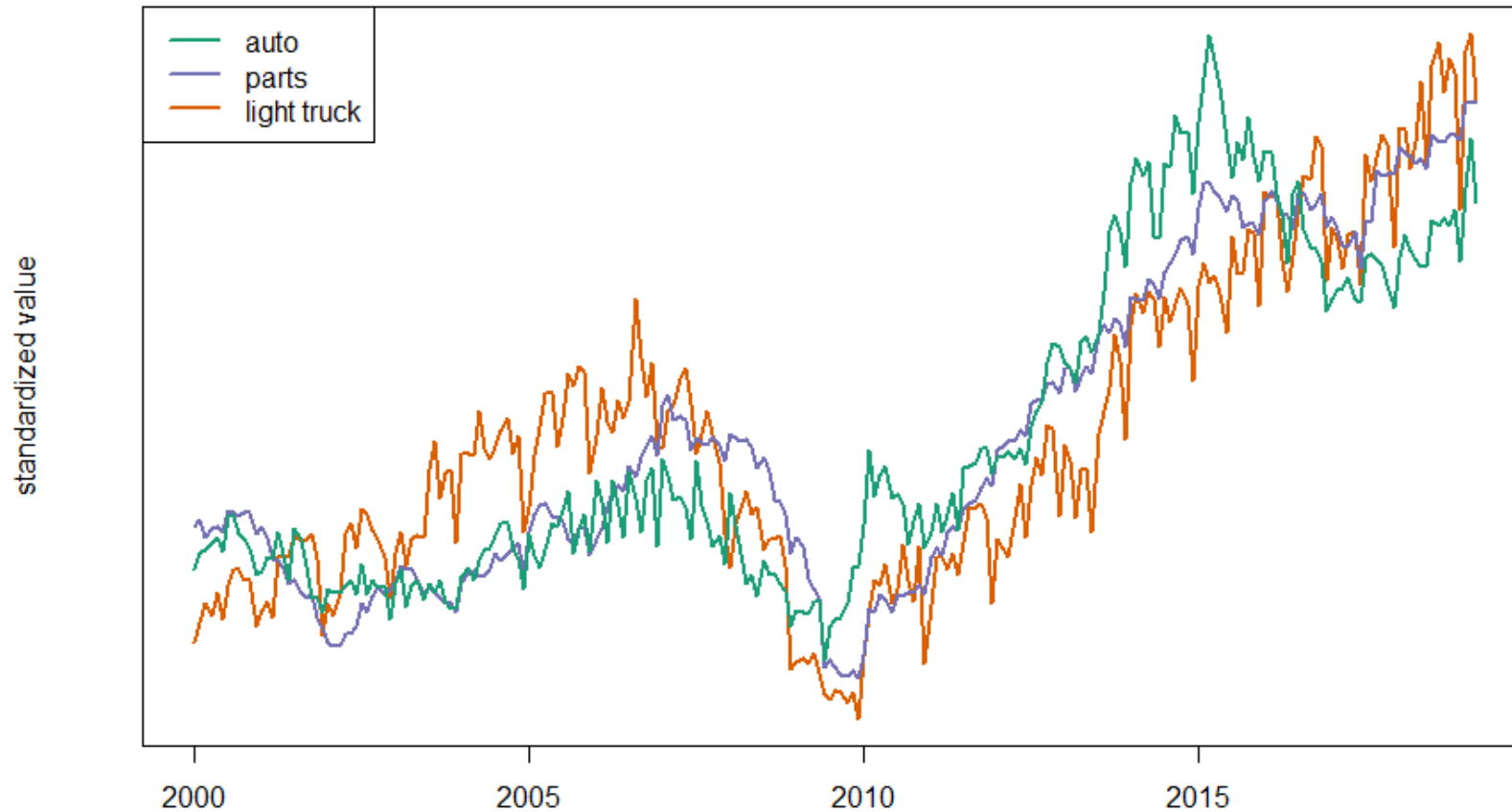
Source: U.S. Census Bureau, Manufacturers' Shipments Inventories, and Orders, <www.census.gov/manufacturing/m3/index.html>

Inventories in Millions of Dollars (not adjusted for seasonality or inflation)



Source: U.S. Census Bureau, Manufacturers' Shipments Inventories, and Orders, <www.census.gov/manufacturing/m3/index.html>

Standardized Inventories (not adjusted for seasonality or inflation)



Source: U.S. Census Bureau, Manufacturers' Shipments Inventories, and Orders, <www.census.gov/manufacturing/m3/index.html>

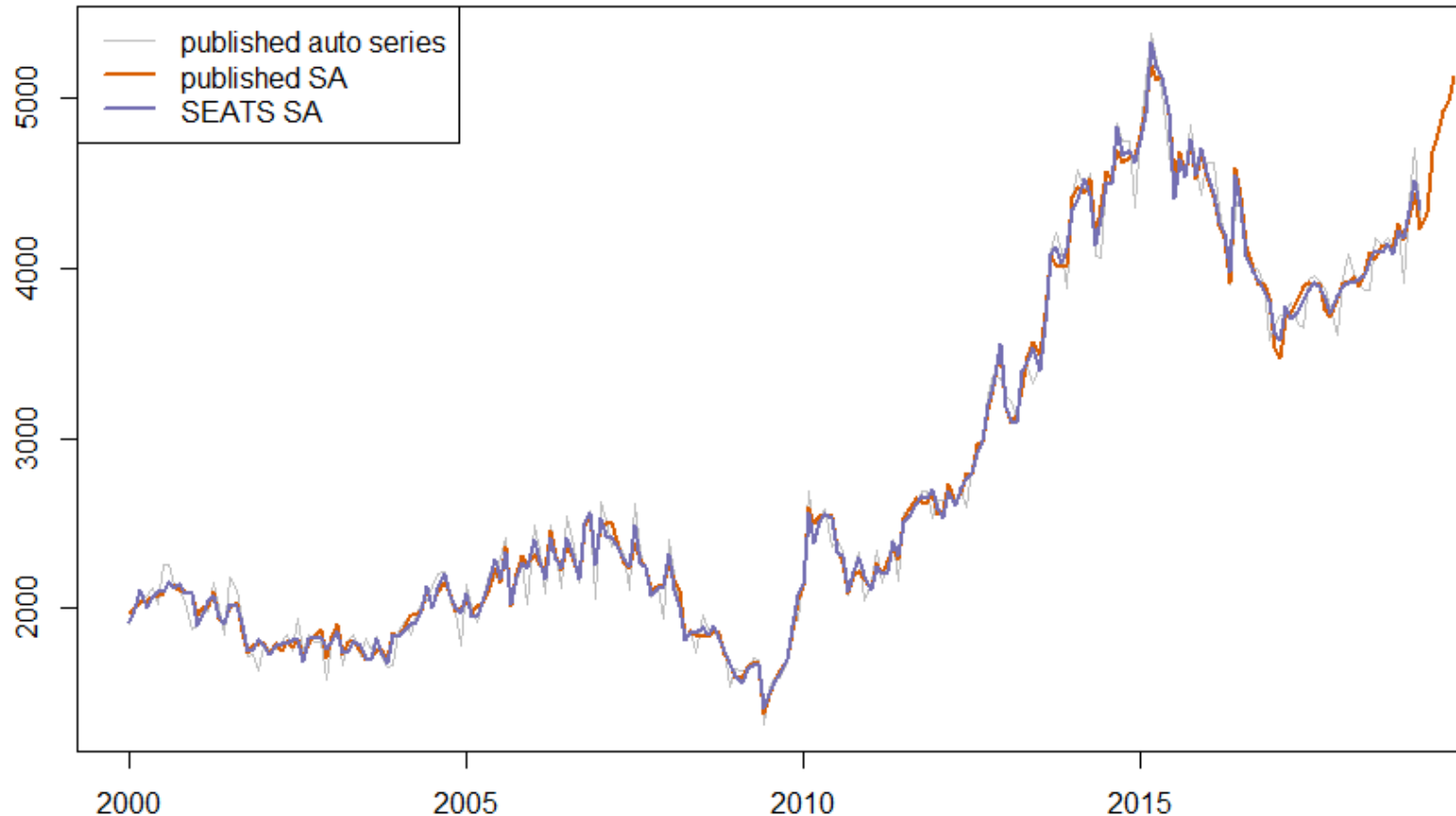
Note: "parts" is the M3 series "BTP"

SEATS Adjustment

$$X_t = T_t + S_t + I_t$$

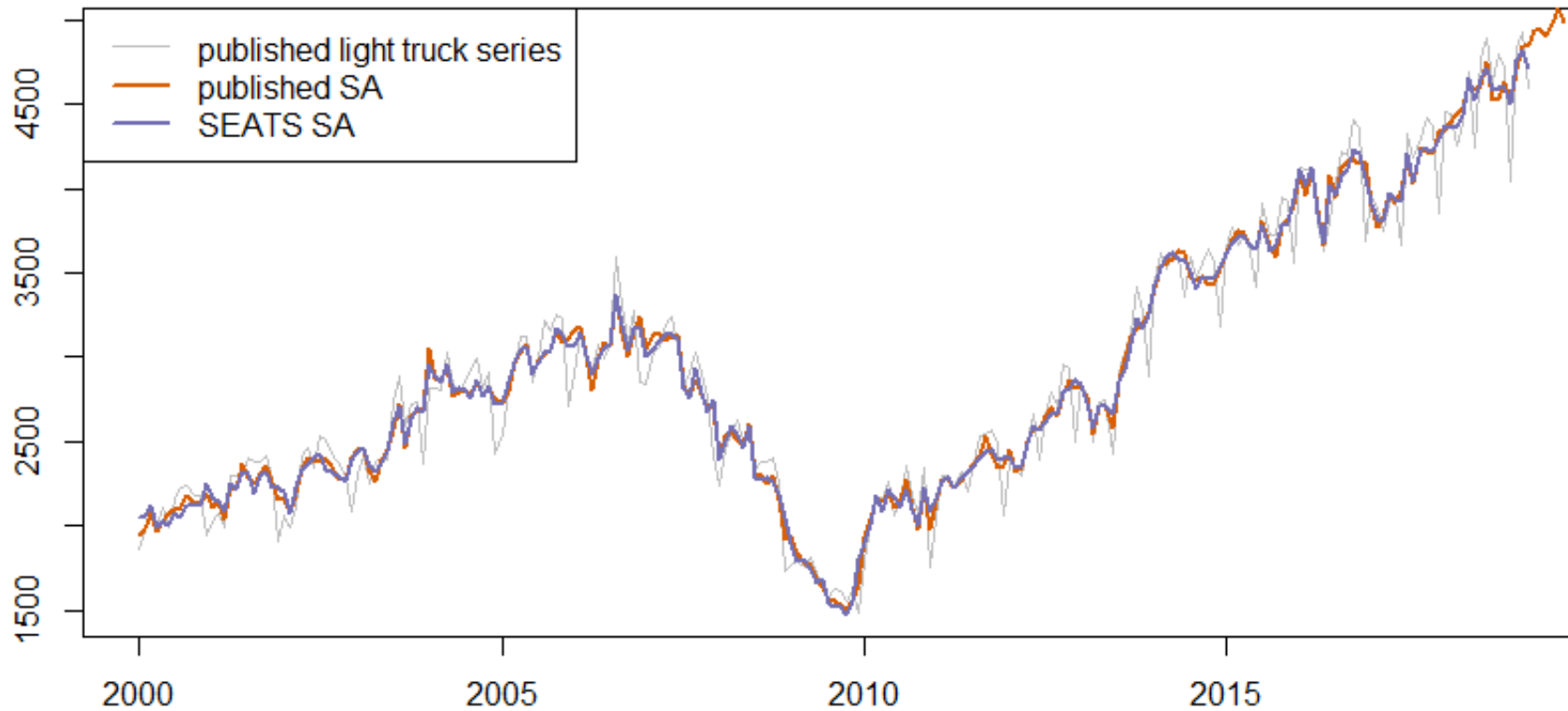
- X-11 and SEATS estimate the unobserved components by passing moving average filters over the observed data.
- X-11 filters
 - Finite set of empirically derived filters
- SEATS filters
 - Specify stochastic models for unobserved components
 - Derive seasonal adjustment filters from these models
 - Infinite number of possible filter choices
 - Requires more statistical machinery
- Prior work has been done at the Bureau of Labor Statistics and the Census Bureau comparing X-11 and SEATS adjustments

Automobile Manufacturing: SEATS compared to Published SA



Source: U.S. Census Bureau, Manufacturers' Shipments Inventories, and Orders, <www.census.gov/manufacturing/m3/index.html>

Light Truck Manufacturing: SEATS compared to Published SA



Source: U.S. Census Bureau, Manufacturers' Shipments Inventories, and Orders, <www.census.gov/manufacturing/m3/index.html>

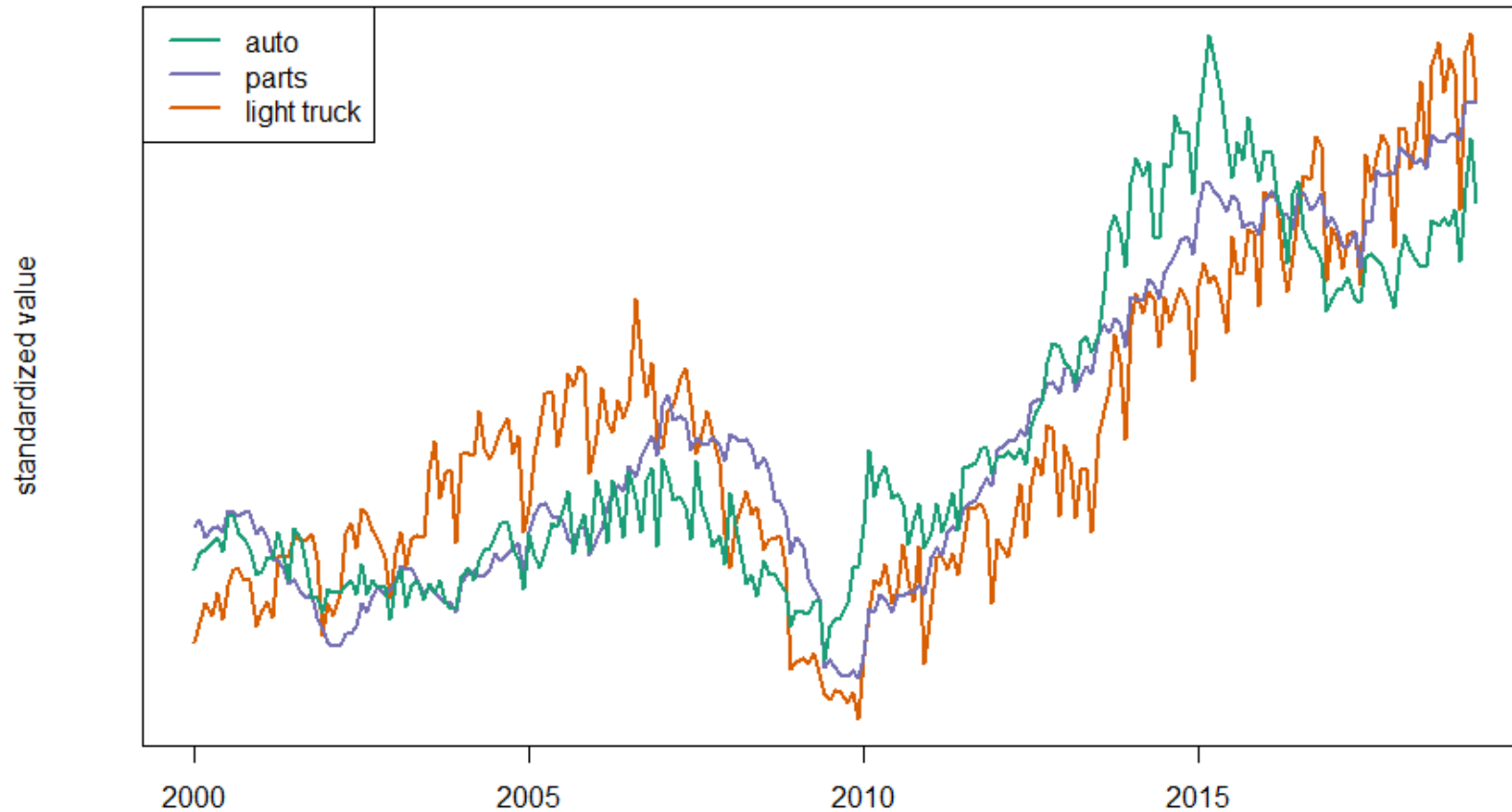
Multivariate Signal Extraction

- The main idea: estimate trend and seasonal components jointly

$$\begin{pmatrix} X_{t,1} \\ X_{t,2} \end{pmatrix} = \begin{pmatrix} T_{t,1} \\ T_{t,2} \end{pmatrix} + \begin{pmatrix} S_{t,1} \\ S_{t,2} \end{pmatrix} + \begin{pmatrix} I_{t,1} \\ I_{t,2} \end{pmatrix}$$

- Advantages: borrow strength to correctly identify movement
- Disadvantages: numerical & statistical complexity
- Implementation: custom *ecce signum* software developed at Census Bureau

Standardized Inventories (not adjusted for seasonality or inflation)



Source: U.S. Census Bureau, Manufacturers' Shipments Inventories, and Orders, <www.census.gov/manufacturing/m3/index.html>

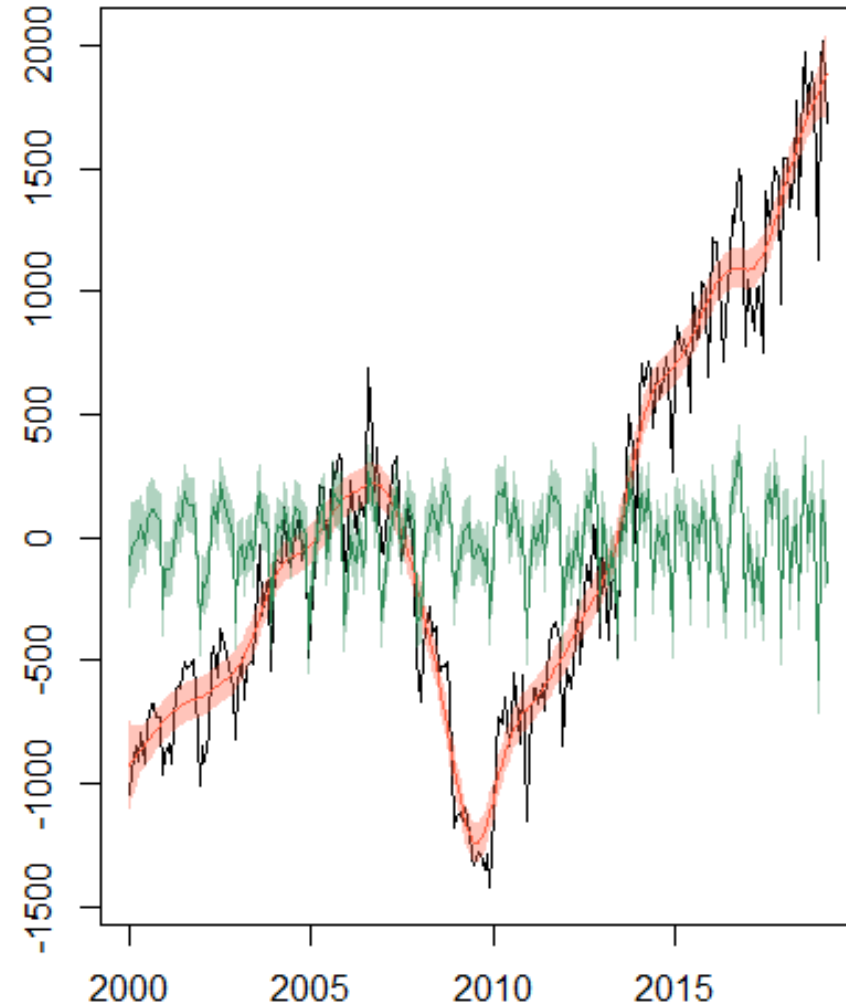
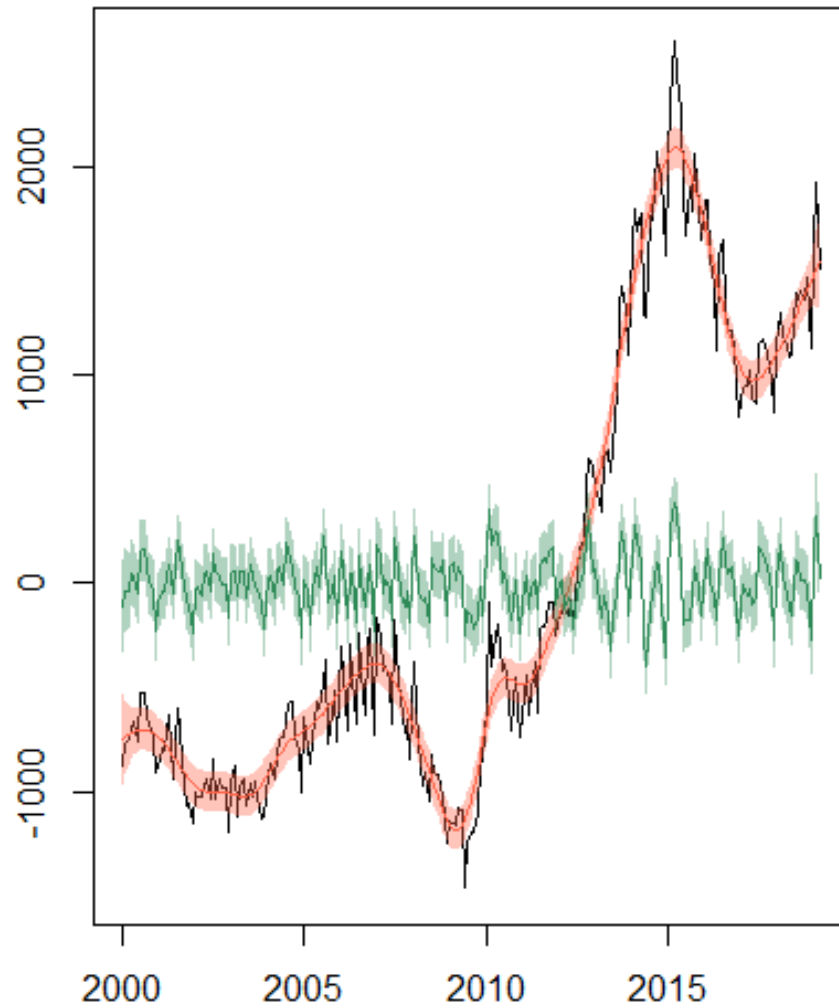
Note: "parts" is the M3 series "BTP"

Ecce Signum (sigex) Software

- R package provides multivariate time series models for structural analysis
- Allows latent signals such as trends or seasonality
- Models are fitted using maximum likelihood estimation
- Allows for non-stationarity, fixed regression effects, missing values
- Model adequacy is assessed through residual diagnostics
- Model-based signal extraction filters can be assessed in time domain and frequency domain

Ecce Signum - Latin for "Behold the Proof"; cf. Falstaff's speech in *Henry IV, Part 1* (Act 2, Scene 4).

Sigex applied to auto and light truck series



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