Variable Selection for long-term forecasting using temporal aggregation

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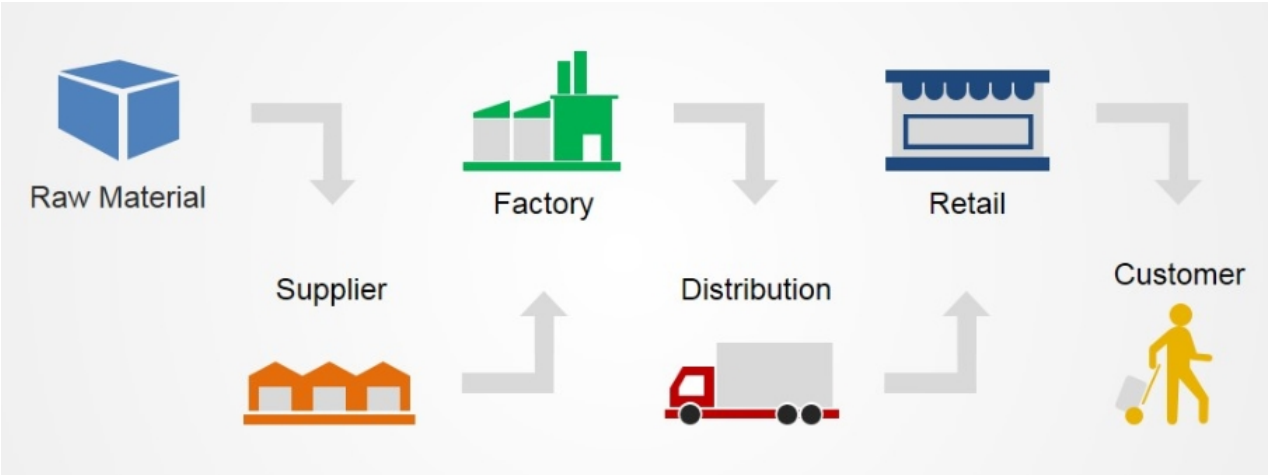
21/06/2016

Supply Chain Management constraints

Long term decisions require a good sales forecast



- Raw material
- Procurement negotiations
- Manufacturing and labor scheduling
- Capacity constraints
- Transportation

Traditional Sales Forecasting

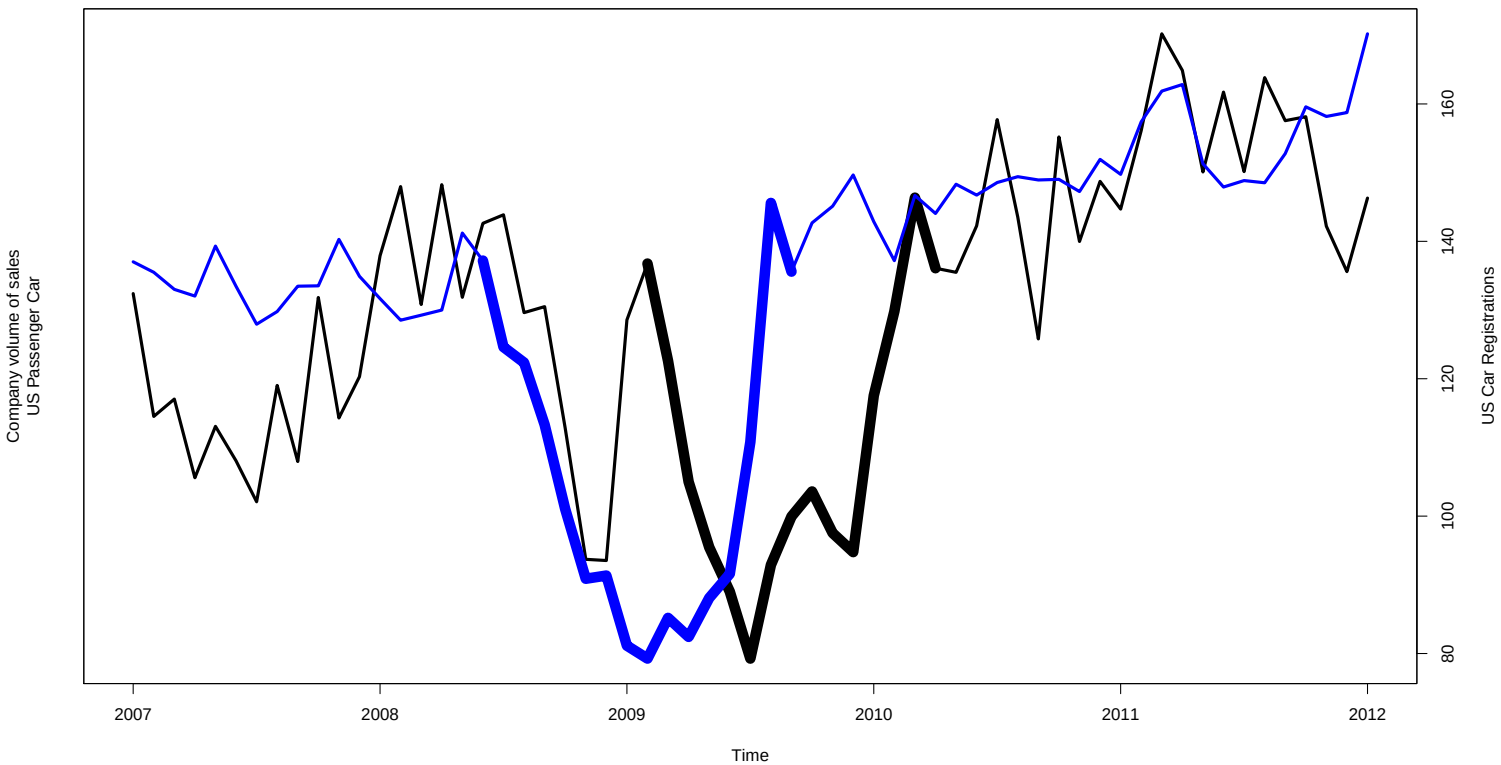
Long term sales forecasting are formulated:

- Historical data patterns (level, trend, seasonality, ...)
- Promotions
- Judgemental adjustments:
  - Collaborative input from clients
  - Newspapers and industry magazines
  - Rumors in the corridors

  Judgemental input is known to be biased and inconsistent (Fildes and Goodwin 2007, Trapero et al. 2013)
- Information of exogenous leading indicators
  - Capturing market sentiment in external big data (Russom et al. 2011)

Leading Indicator Example: Tires for passenger cars (US)

The amount of newly registered cars (blue) is a leading indicator to the sudden drop (bold) in car tire sales (US) during the economic crisis of 2009-2010.



The curses of leading indicators

Curse of dimensionality

- Short fat data problem
- $p > n$: much more predictors than training sample

Curse of optimal leading effect

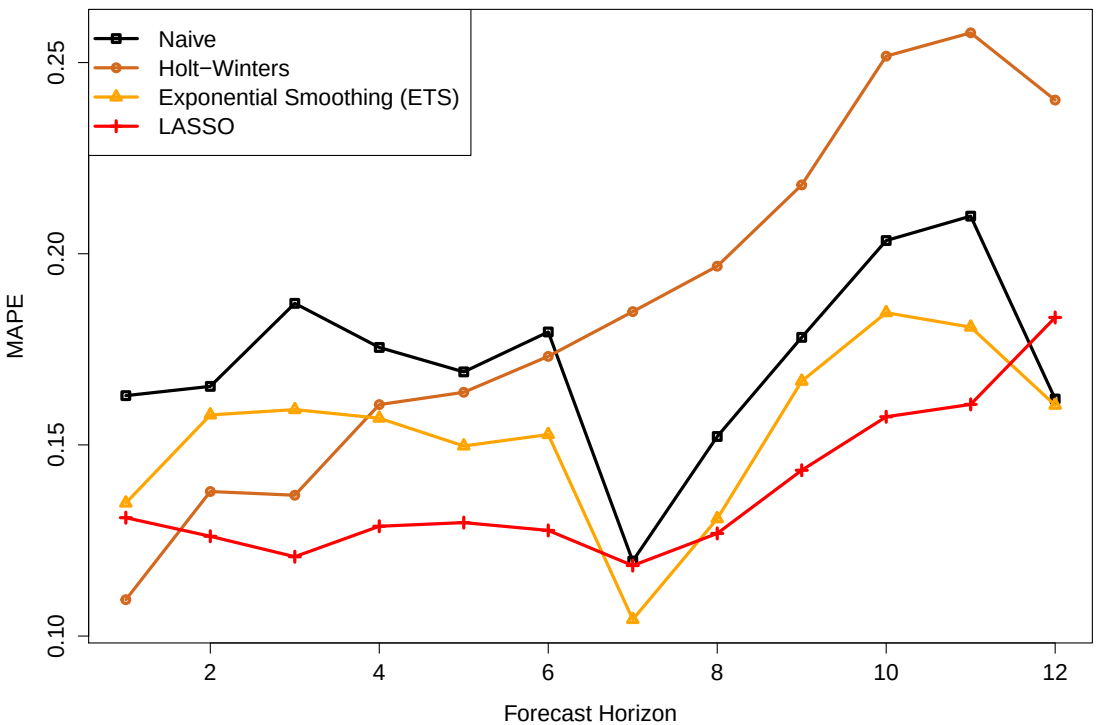
- Leading indicators exhibit leading information in advance
- $pl \gg n$: detecting optimal lead expands dimensionality

Curse of missing future information

- Indicators only exhibit information up to a certain point in time
- Clear need for unconditional forecasting

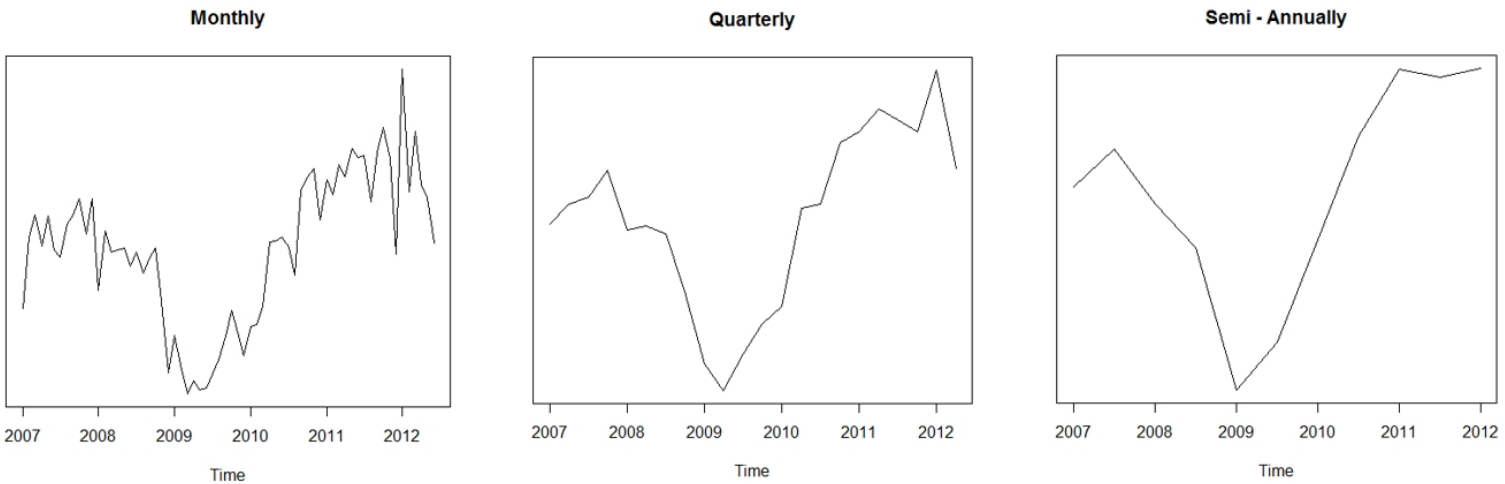
First results

LASSO with limited sales history can improve on the company benchmark and on ETS



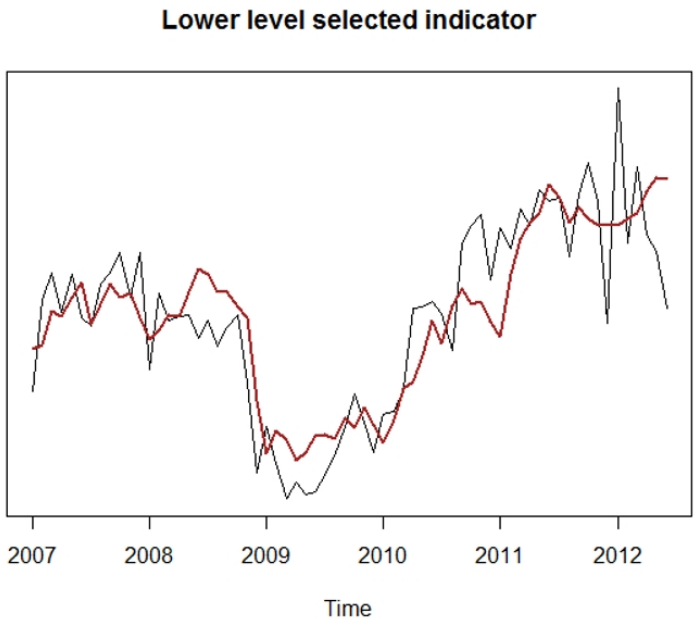
Model	MAPE
Naive	17.205
Holt-Winters	18.590
Exponential Smoothing (ETS)	15.323
LASSO	13.781

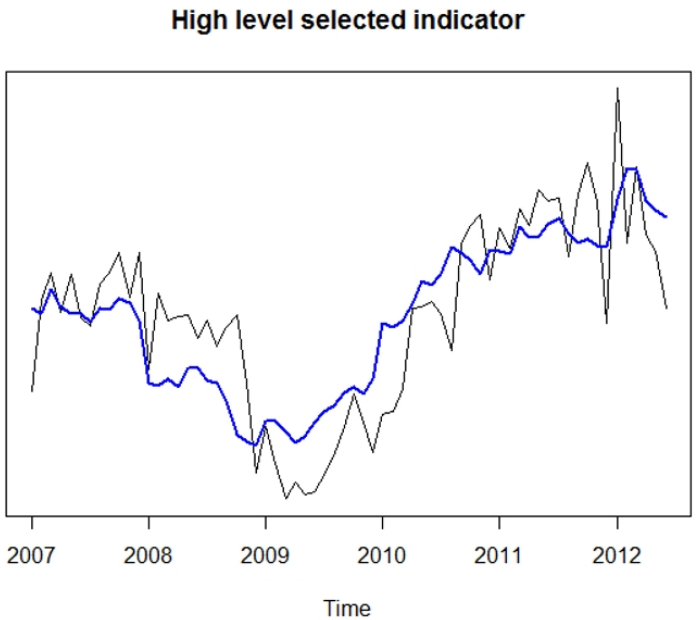
Temporal aggregation



- Lower levels contain more noise and short term dynamics
- Cycles cannot be detected on lower frequency
- Capturing cycles is interesting for long term predictions

Temporal aggregation





- Indicator selected on lower levels contains more variance
- Indicator selected on high level is slower moving

Methodology

Variable selection

- Low level:

$$\hat{Y}_i = \beta_0 + \sum_{k=1}^{S} \beta_k D_k + \sum_{j=1}^{P} \beta_i x_{ij}, \tag{1}$$

  seasonality selected on AIC

- High level:

$$\hat{Y}_i = \beta_0 + \sum_{j=1}^{P} \beta_i x_{ij} \tag{2}$$

Forecast modeling on low level:

- Seasonality if selected
- Predictors selected on low/high level

Example results

The relative MAPE improvement between both variable selection methods

	1-6 months	6-12 months
Low level	5 - 7 %	
High level		1 - 6 %

Questions?

Thank you for your attention !

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