Accurate Retail Testing of Fashion Merchandise: Methodology and Application
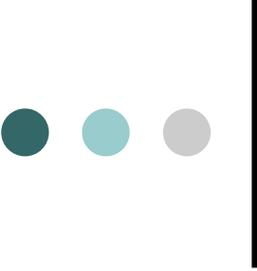
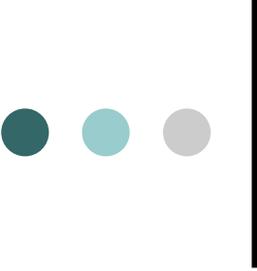By: *Marshall Fisher*

Kumar Rajaram
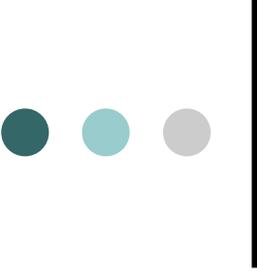
Presenter: Adrien de Chaisemartin

04/13/2004

Agenda

- General description of the method

- Model description

- Application to a women's specialty apparel retailer

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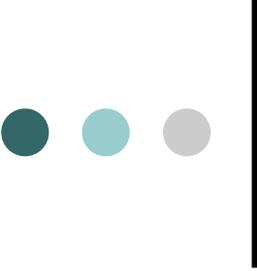- Application to a women's specialty apparel retailer

Problematic of fashion products

- Segment of merchandises:
  - Basic
    - Long life cycle
    - Easy to forecast demand and manage inventory

  - Fashion
    - Short life cycle
    - Highly unpredictable

- Problem of forecast for fashion products
- Can lead to tremendous cost due to:
  - Overproduction / Underproduction
  - Wrong repartition of the articles
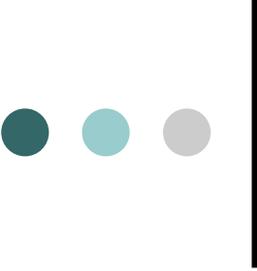
Tests for fashion products forecasts

- Small sample of articles put in some stores before the selling season
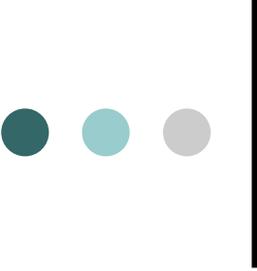
- Observation of customer reaction

- Forecasting of the fashion products sales in the coming selling season

Problems raised by tests:
a trade-off to find

- Costs of tests:
  - Administrative
  - Need extra-inventory to avoid shortage
  - Space used

- Trade-off to find:
  - Number of stores
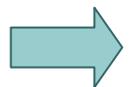 - Duration of the tests
  - Dates of the tests
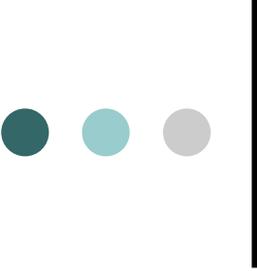
Questions raised by the paper

○ Questions:

- Which stores should we choose for the tests?
- How to create forecasts with their results?

○ Motivation:

- No previous rigorous analysis of the problem
- A better forecasting increases the profit by a large quantity ⟶ An important leverage is possible
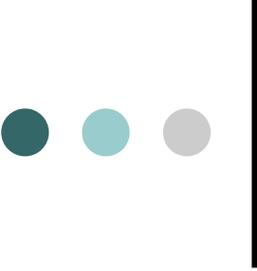- Even the merchandisers recognize that their forecasting methods are deficient

⟹ The paper will give a general and basic framework to rationalize the tests and the forecast procedures

Methodology (I)

- We know:
    - The products the company wants to test
    - The sale season
    - The test period
    - The number of stores in which tests will be conducted

- Duration of the test:
    - Trade off to find
    - Typically: 2 or 3 weeks just prior to the sale season

- Data on previous sales for each product will be taken from the "primary season" (i.e. Season when the product is sold at its initial price and when there is no stock out) to remove external factors from consumers behavior
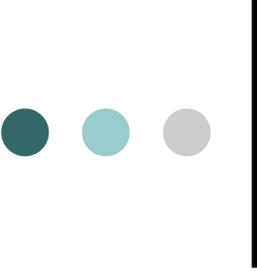
Methodology (II)

- Idea of the method (with k stores to choose to run the tests):
  - Gathering the stores in k clusters by customer preferences
  - Choosing the "best" store in each cluster to represent its cluster

- The objective function will be the cost of the forecasting errors based on previous data

- In general the cost of the error is defined with:
  - S_p actual demand for product p
  - $\hat{S}_p$ forecast demand for product p
  - U_p cost of producing less then demanded
  - O_p cost of producing more then demanded

$$\text{Cost:} \quad U_p\,(S_p - \hat{S}_p)^+ + O_p\,(\hat{S}_p - S_p)^+$$
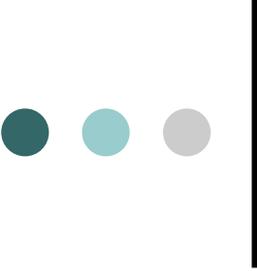
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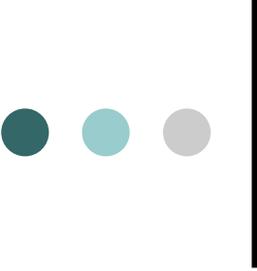- Application to a women's specialty apparel retailer

Model description

(See "Model Description" on pages 269-70
of the Fisher and Rajaram paper)

Construction of the objective function (I)

- If store i is represented by store j (i.e. they are in the same cluster and j represents the cluster in the test):

  - Forecast for product p in store i will be $(w_i / w_j) S_{jp}$
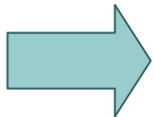 - The cost associated with this forecast will be:

$$\sum_{p=1}^{m} O_p (\frac{w_i}{w_j} S_{jp} - S_{ip})^+ + U_p (S_{ip} - \frac{w_i}{w_j} S_{jp})^+$$

$$= w_i \sum_{p=1}^{m} (O_p (\frac{S_{jp}}{w_j} - \frac{S_{ip}}{w_i})^+ + U_p (\frac{S_{ip}}{w_i} - \frac{S_{jp}}{w_j})^+)$$
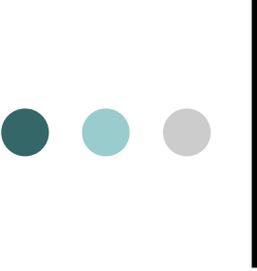
$$= w_i d_{ij}$$

Construction of the objective function (II)

- And so if we define:
  - $y_j = \begin{cases} 1 \text{ if store j is a test store} \\ 0 \text{ otherwise} \end{cases}$

  - $x_{ij} = \begin{cases} 1 \text{ if store i is assigned to a cluster represented} \\ \quad \text{by test store j} \\ 0 \text{ otherwise} \end{cases}$

- We have the objective function:
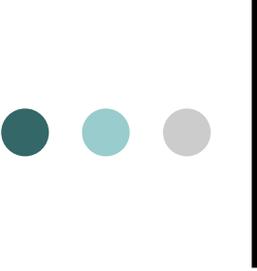
$$Min \sum_{i \in I} \sum_{j \in I} w_j d_{ij} x_{ij}$$

Constraints on the objective function

$$\forall i \; \sum_{j \in I} x_{ij} = 1 \qquad \text{There is exacly one representative per cluster}$$

$$\sum_{j \in I} y_j = k \qquad \text{There are k representatives}$$

$$0 \le x_{ij} \le y_j \le 1 \qquad \text{If j is not a representative then } x_{ij} = 0$$
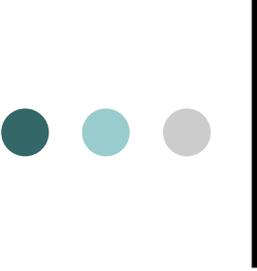
Other possible clustering

- d_{ij} can be based on a weighted combination of sales descriptor such that:
  - Distance
  - Temperature
  - Ethnicity and neighborhood type
  - Size and location of the store

- d_{ij} can be also a combination of the store descriptors and the sales mix

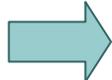- Stores could be also clustered with a least square method on the sales

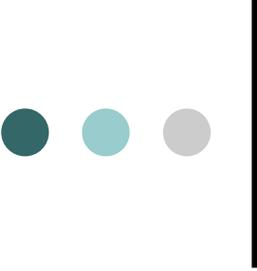Result will be compared during the application

After the test: the forecast

○ The sales in a store during the test period can correspond to a period with particular high or low sales in the year.

⟹ Necessity to find, for each cluster, the relation between the annual sales and the sales realized during a period comparable in time and duration to the test period (Those sales are denoted $\overline{S}_{ip}$). This relation will be given by the coefficient $\alpha_1 \dots \alpha_k$ found with the following optimization problem:

(See the equations and explanation in the left hand column of page 271 in the Fisher and Rajaram paper)
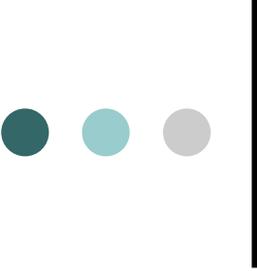
Intuition for the $\alpha_1 \dots \alpha_k$

(See the equations and explanation in the left hand column of page 271 in the Fisher and Rajaram paper)
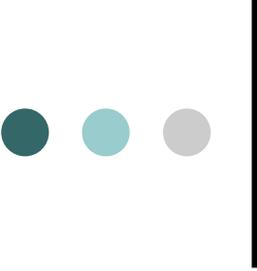
➡ This problem is at its minimum when $\hat{S}_p \simeq S_p \simeq \sum \alpha_i \overline{S_{ip}}$

This gives the relation between the total annual sales and the sales on a period equivalent to the test period
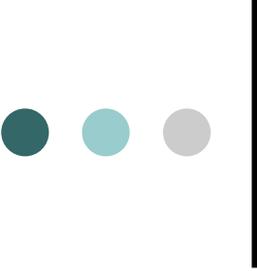
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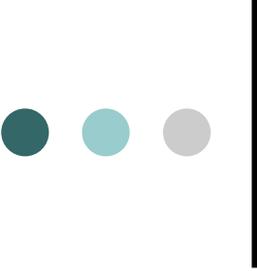# Application to a women's specialty apparel retailer: methodology

- Sales recorded for 250 products for year 1993:
  - Determination of the primary sale period: 10 weeks
  - 125 products used to calculate the parameters of the problem (clusters, representatives, $\alpha_1 \dots \alpha_k$)
  - Application of the model to the 125 other products. The first two weeks of the primary sale season are considered as test weeks for those products
  - We make the forecast for those products for the entire primary season $\hat{S}_p$
  - We calculate:
    - The forecast error: $\sum_{i=1}^{k} \left| \hat{S}_p - S_p \right|$
    - The cost of this error: $\sum_p O_p \left(\hat{S}_p - S_p \right)^+ + U_p \left(S_p - \hat{S}_p \right)^+$

Application to a women's specialty apparel retailer: results

(See Table 1 on page 273 of the
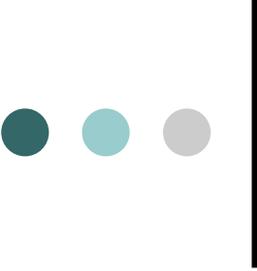Fisher and Rajaram paper)

- Efficiency based on the fact that the objective function tackles directly the goal of the company that is minimizing the cost due to forecast errors.
- All the other methods aim at this goal but use indirect means
- The sale mix is correlated to temperature and ethnicity but not size and location of the stores

Impact of test period length

(See Table 3 on page 275 of the
Fisher and Rajaram paper)

- A posteriori the choice of a 3 weeks periods seems to be a efficient

Conclusion

- Simple and straightforward idea: clustering the stores merely in terms of customer sales

- Furthermore this method gives a forecast not only for the whole chain but adapted to every store

- Seems to be efficient but the mean used to compare the different methods uses directly the minimized objective function…

- Realistic model for the costs of forecast errors?

Questions?