

# Putting windows in the black box

Developing a set of diagnostic and analytical tools to support multilateral price indexes in production

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Checkout the project site (examples, paper, code, and more!)

## 1 MOTIVATION

- Multilateral methods take as input a large number of records and involve a lot of calculation. Notably:
  - GEKS family - multilayered bilaterals
  - TPD and TDH - large scale regression models (typically with sparse matrices)
- Hard to analyze** - Unlike traditional (bilateral) methods, not intuitive to understand and explain the drivers of price change
- Opacity introduces risk** - lack of understanding also implies it is hard to detect issues

NSOs must validate that everything operates effectively & be able to understand (and explain) movements.

**Goal of the project:** Define and demonstrate representative analytical outputs and supporting diagnostics with open data to (1) lead to a consensus and (2) simplify adoption

## 2 MULTILATERAL CONSIDERATIONS

Potential issues to look out for depend on the class of multilateral:

- TDH - estimated using product characteristics
- TPD/GEKS - use appropriate product id (i.e. homogeneous product)

Characteristics or products thus need to be consistently defined for the length of the window.

Main risk: if coding of (1) characteristics or (2) product ids change within the window -> an incorrect movement will occur.

## 3 DEFINING DIAGNOSTICS

### MONITORING / VALIDATION

**Goal:** Check that the data was received and is reasonable

Examples:

- Revenue by store / retailer
- Number of unique products (or rows)
- Average value per unique product code
- Quantities and prices aligned to historic trends

### INPUT DIAGNOSTICS

**Goal:** Check that the data is structured appropriately for input to multilateral indices, and errors have been followed up.

Specifically:

- Churn in unique products (could be due to data issues, misclassification, or other coding/processing issues).
- Missingness in product characteristics
- Unit prices and quantities lie within historic averages

### ANALYTICAL / OUTPUT DIAGNOSTICS

**Goal:** Understand the quality adjusted price change & pick up on issues (whether with the data or the estimation process).

Example analytical outputs:

- Decompose into 'points effects'
- Aggregate points effects for characteristics such as brand, type of product, etc

Example output diagnostics:

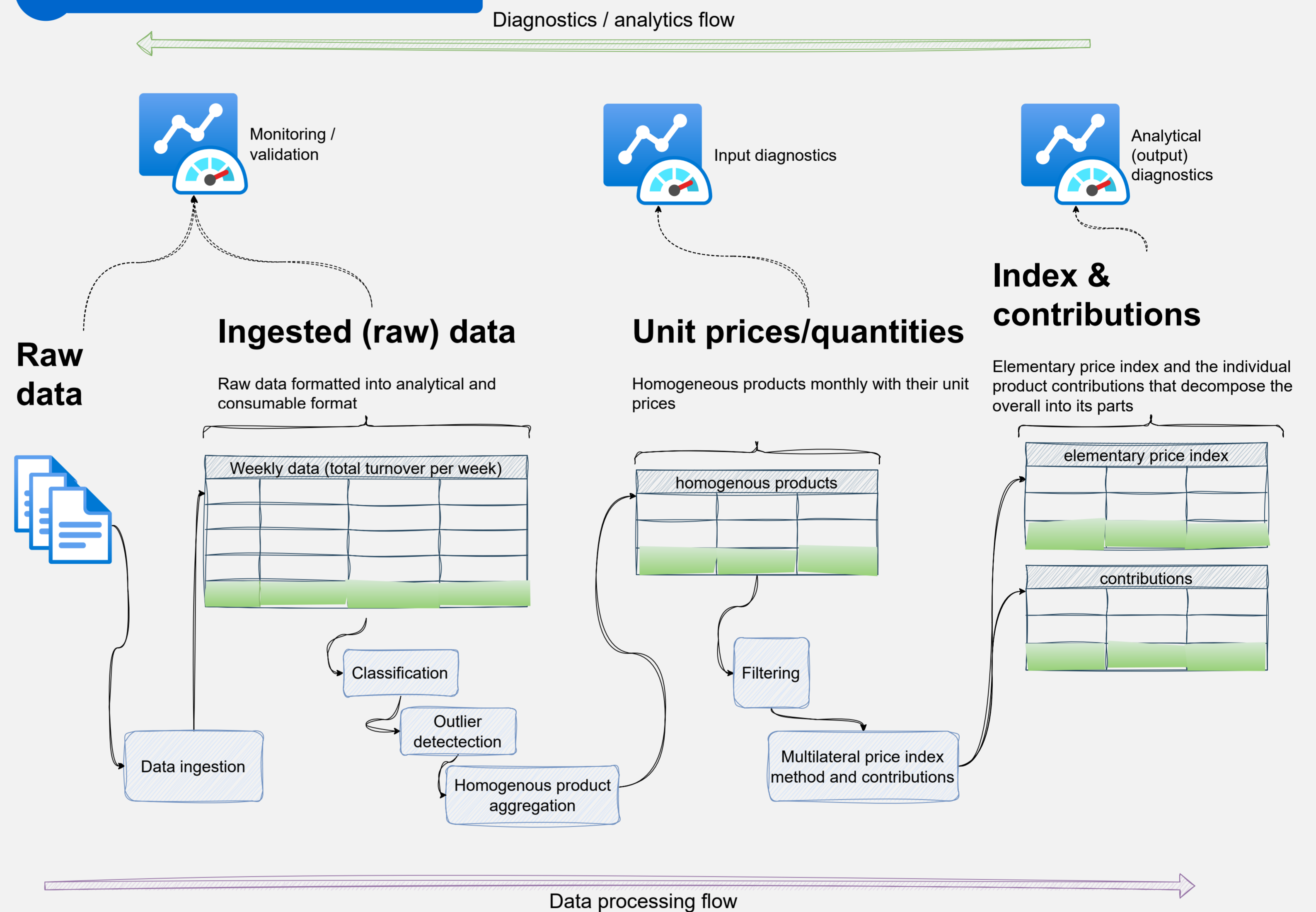
- Validating products with contributions (i.e. points effects) over an expected threshold.
- Compare index movements for previous periods between this production run and previous runs

### WHEN IS IT ENOUGH?

Not all possible scenarios can be forecasted, but common dashboards should answer most questions (or alert for further investigation) - i.e. '80-20 principle'

Structured (and well documented) data pipeline key to support analysts to investigate further as needed.

## 4 DATA FLOWS



Example data flow:

- Step 1: Raw (weekly) data files are received.
- Step 2: Raw data files are loaded into internal data store that supports simpler analytics.
- Step 3: Classification, outlier detection and aggregation by homogenous products (i.e. aggregation across time, geography, and products) is carried out.
- Step 4: Price Index calculation and output of contributions

Both will power monitoring and validation diagnostics.

Output data supports main input diagnostics

Output data supports both analytics and output diagnostics

## 5 EXAMPLE WITH DOMINICK'S DATA

### MONITORING / VALIDATION

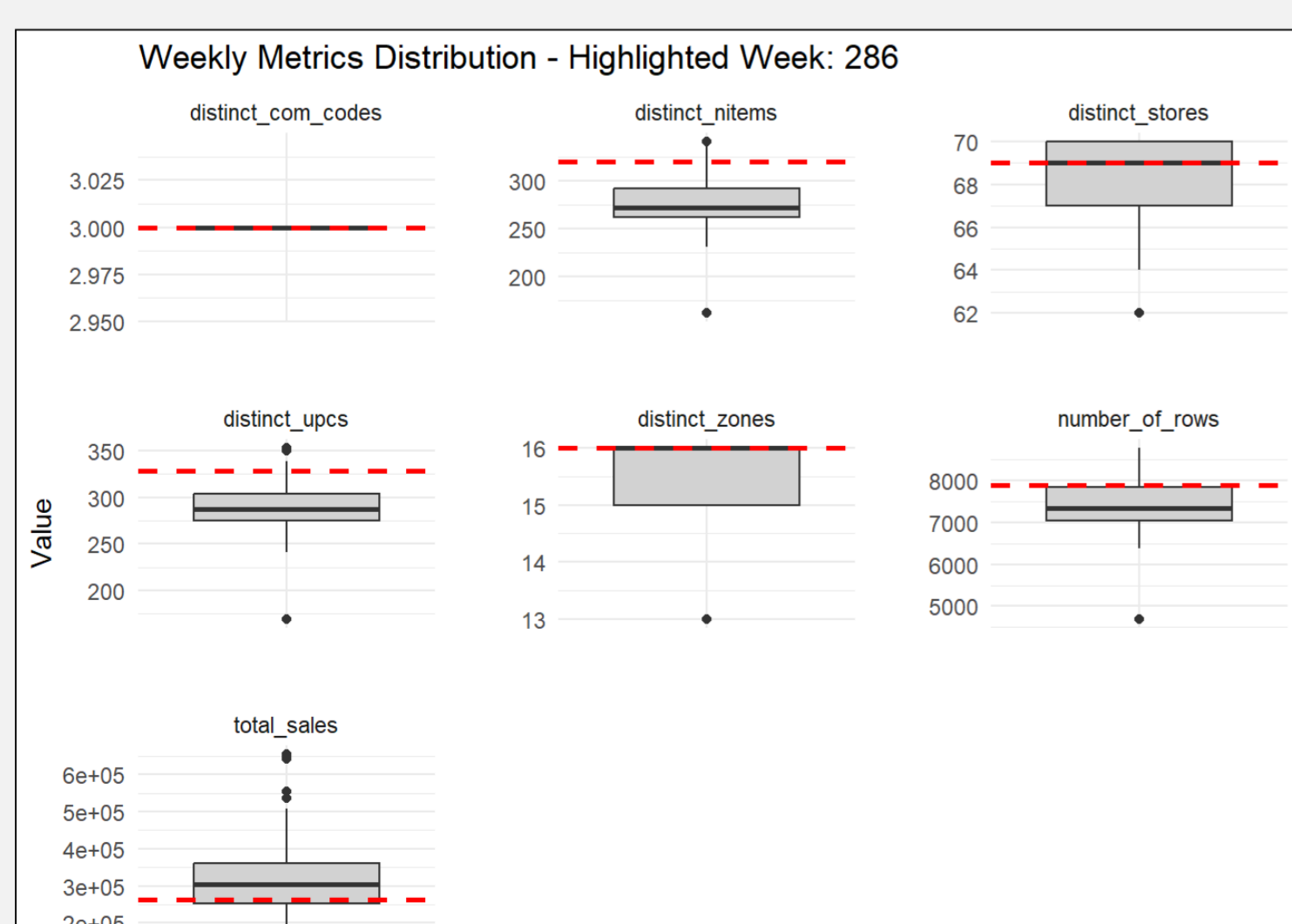


See interactive examples online

Example weekly summary

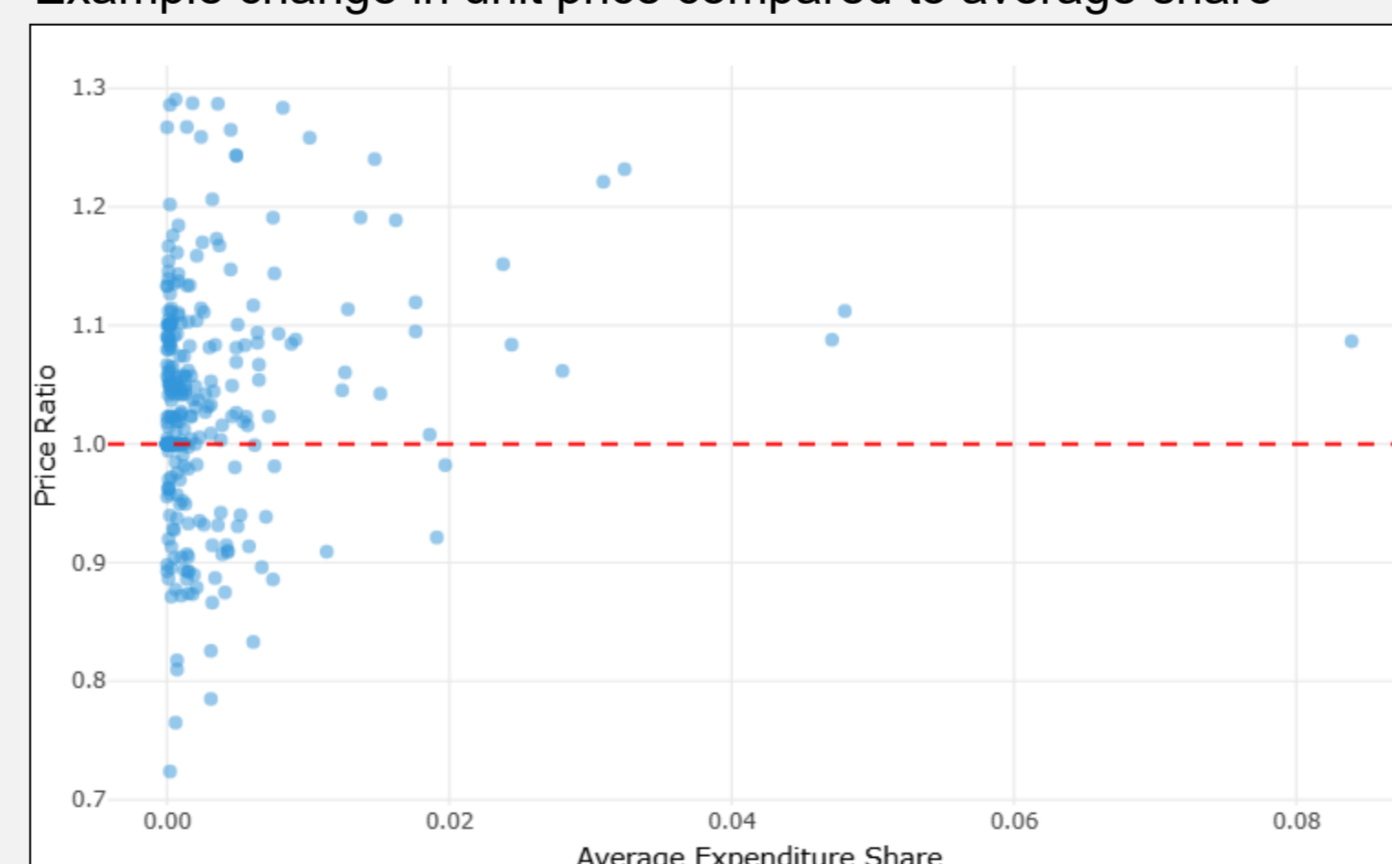
WEEK	number_of_rows	total_sales	week_start	week_end
1	286	7880	1995-03-02	1995-03-08
2	287	8181	1995-03-09	1995-03-15
3	288	8098	1995-03-16	1995-03-22
4	289	8144	1995-03-23	1995-03-29

Example statistics per week

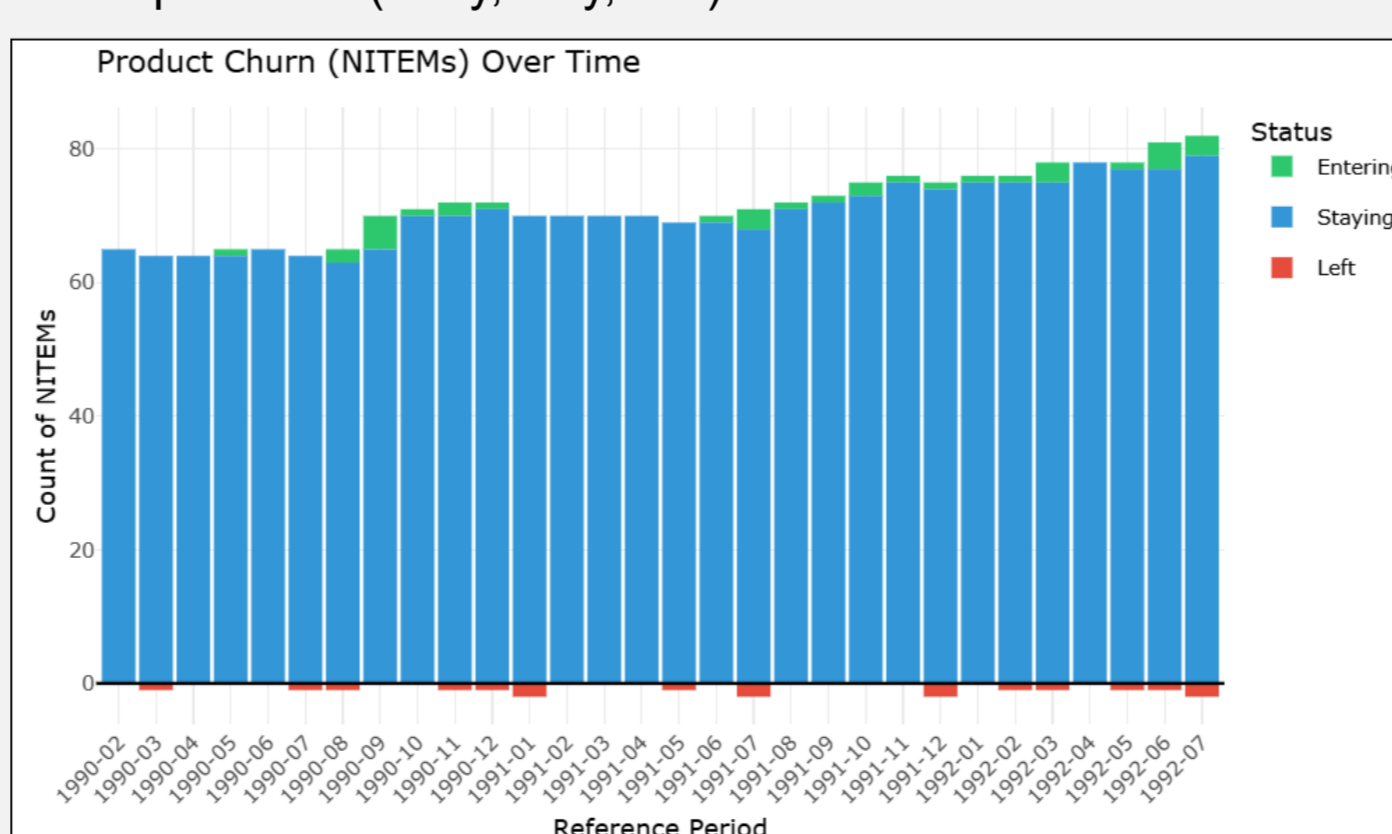


### INPUT DIAGNOSTICS

Example change in unit price compared to average share

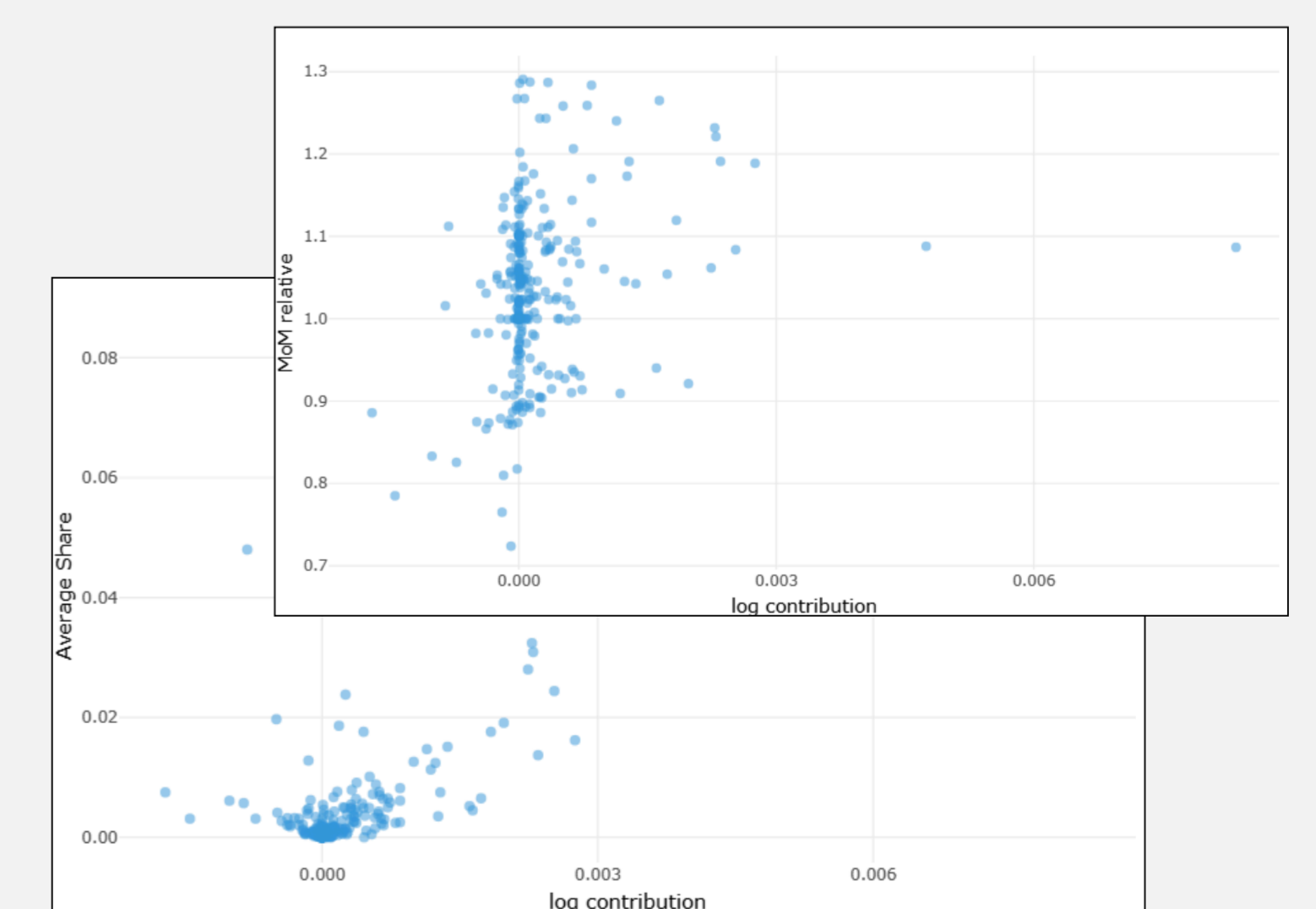


Example churn (entry, stay, exit)



### ANALYTICAL / OUTPUT DIAGNOSTICS

Example overview of product contributions compared to their share in the index or the observed price change



## 6 NEXT STEPS

Current empirical example focuses on Dominick's dataset and GEKS calculation. Next steps include:

- Expand to TPD and TDH methods
- Expand to additional open datasets
- Validate that dashboards generalize all use cases
- Standardize code into a package (if of value)