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# On the impact of inventory accuracy improvements on sales

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# About us

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## ■ Christoph H. Glock

- Professor: Technical University of Darmstadt, Germany
- Specialises in Inventory Optimisation and Warehouse Management

## ■ Yacine Rekik

- Professor: EM-Lyon Business School, France
- Specialises in Inventory Optimisation and Tracking (e.g. RFID) Technologies

## ■ Rogelio Oliva

- Professor: Texas A&M University, USA
- Specialises in Retail Operations, Behavioural Operations and System Dynamics

## ■ Aris A. Syntetos

- Panalpina Chaired Professor: Cardiff Business School, Cardiff University, UK
- Specialises in Statistical Forecasting, Demand Classification & Inventory Optimisation.

## Background and objectives

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- **Inventory inaccuracies: major issue in retailing and apparel industry.**
  
- **Physical stock is (typically) less than what we think it is.**
  - Prior research found that incorrect inventory records may range between 65% and 80%. Simulation studies indicated that inaccurate inventory records may lead to losses in sales of around 1%.
  
  - Thus, reconciling inventories may only lead to an increase in sales.
  
  - *We will see later that positive stock discrepancies are also possible, still leading though to reduced sales!*
  
- **The problem has been established; we are not here to argue for its existence.**

## Background and objectives

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### ■ But instead:

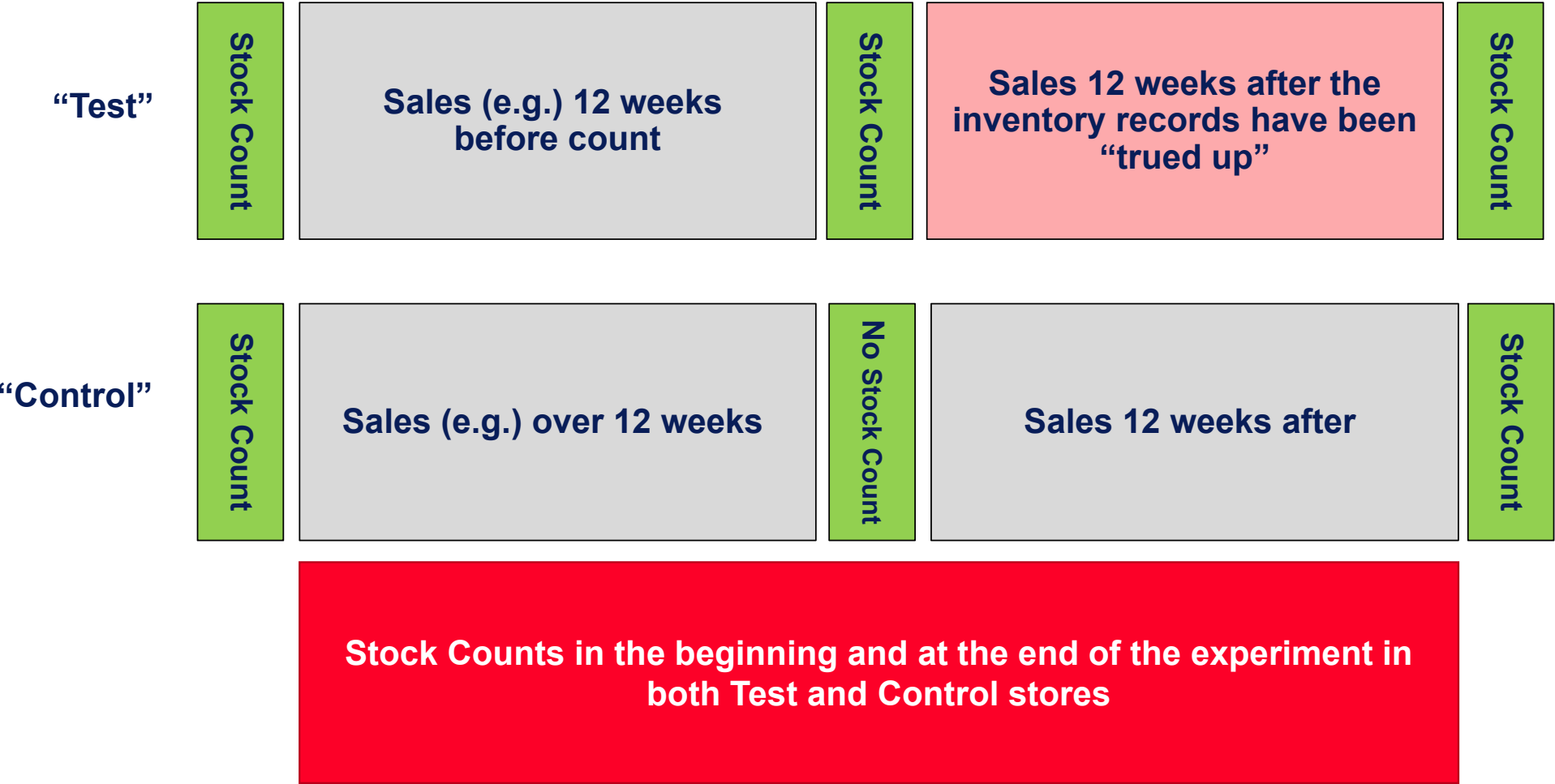
- Assess the implications of the problem, or rather the implications of fixing the problem (phase 1);
- Assess alternative ways of fixing the problem itself (phase 2).

### ■ Phase 1: How does an improvement in inventory accuracy impact sales?

- To what extent are inventory records inaccurate in retailing?
- How do inventory records deteriorate over time?
- How does an improvement in inventory record accuracy affect sales?

### ■ Phase 2 (upon clearly establishing the implications): what are the strategies to be employed (algorithmic driven, new identification technologies, counting, etc.) to fight the root causes of the problem?

# Experiment I: Original / ideal experiment



## Empirical analysis

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- **Conducted with 7 retailers across Europe from two sectors:**
  - Grocery/general (4 retailers – 70 stores – 605,778 SKUs)
  - Fashion/apparel (3 retailers – 21 stores – 428,372 SKUs)

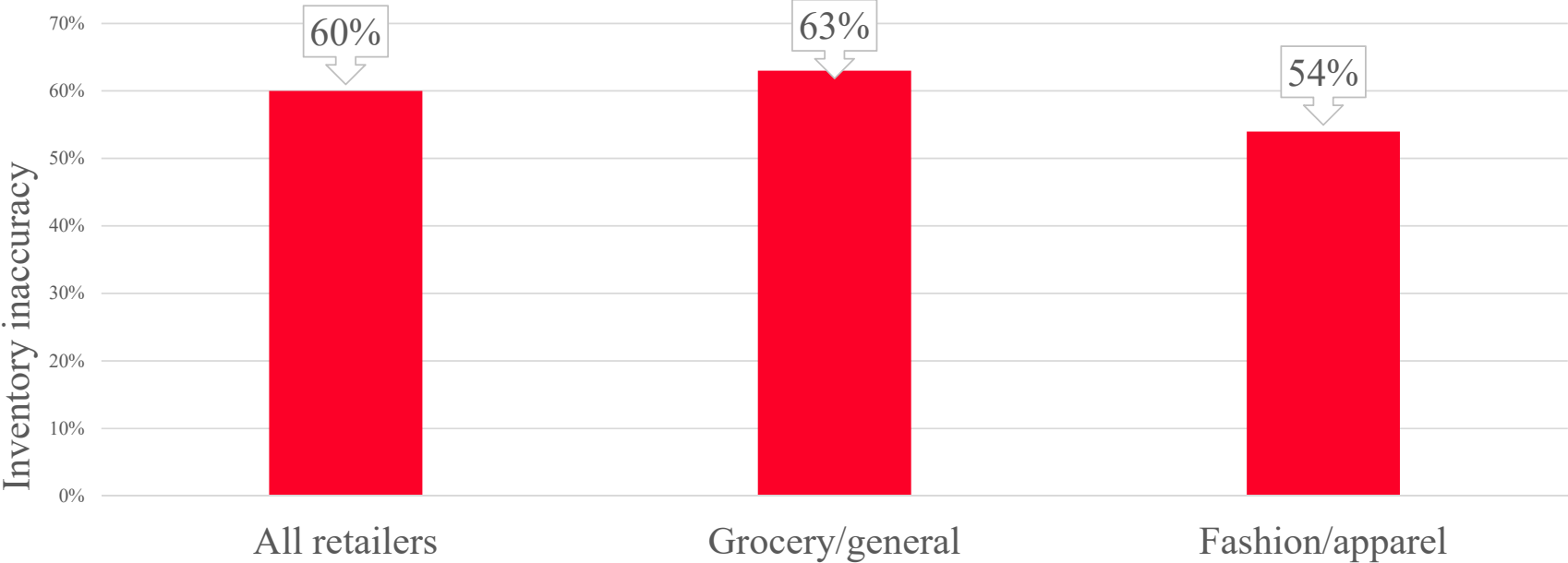
Retailer	No. stores	No. SKUs	Data type	Type
a	20	27,312	Sales, stock data and stocktake reports	Grocery/general
b	12	36,349	Sales and stocktake reports	Grocery/general
c	18	207,501	Sales and stocktake reports	Grocery/general
d	20	334,616	Sales and stocktake reports	Grocery/general
e	3	4,962	Sales and stocktake reports	Fashion/apparel
f	10	2,418	Sales and stocktake reports	Fashion/apparel
g	8	420,992	Sales and stocktake reports	Fashion/apparel
Σ	91	1,034,150		

## **PART I: GENERAL INSIGHTS**

**(summary of insights applying to all retailers)**

# Result 1: Inventory record inaccuracies constitute an important issue

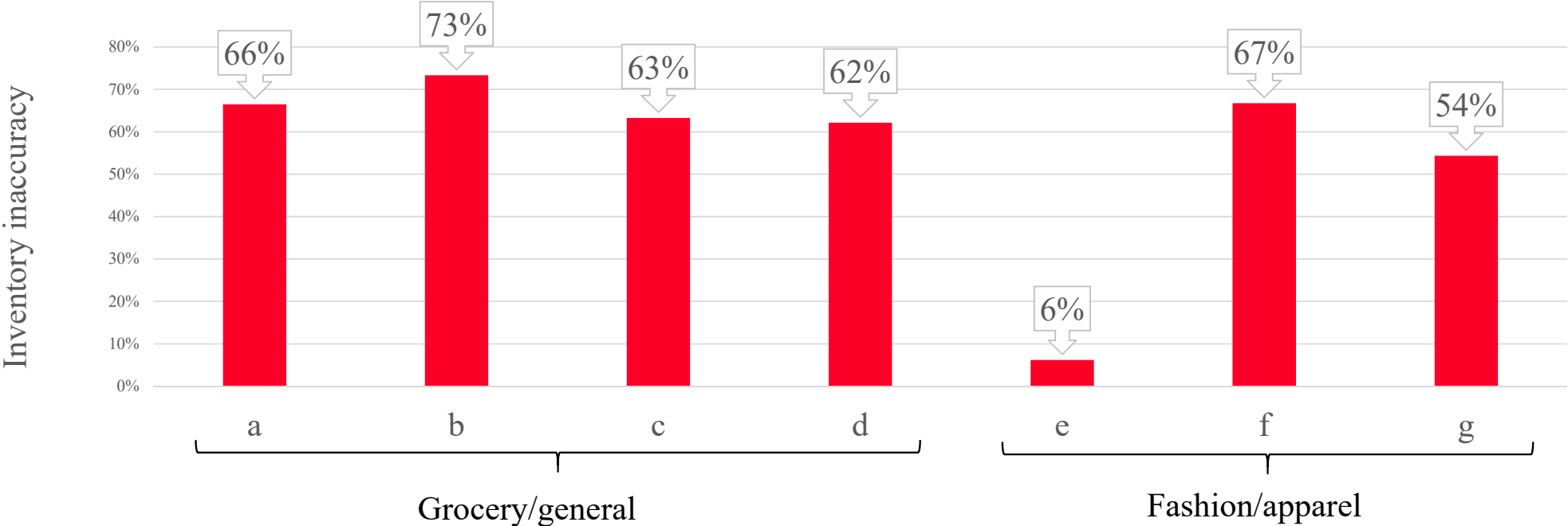
Independent of the experimental setting, inventory record inaccuracies are an important issue for all participating companies: across all retailers, approx. 60% of the audited SKUs are subject to inaccuracies even if a stock take is performed very frequently





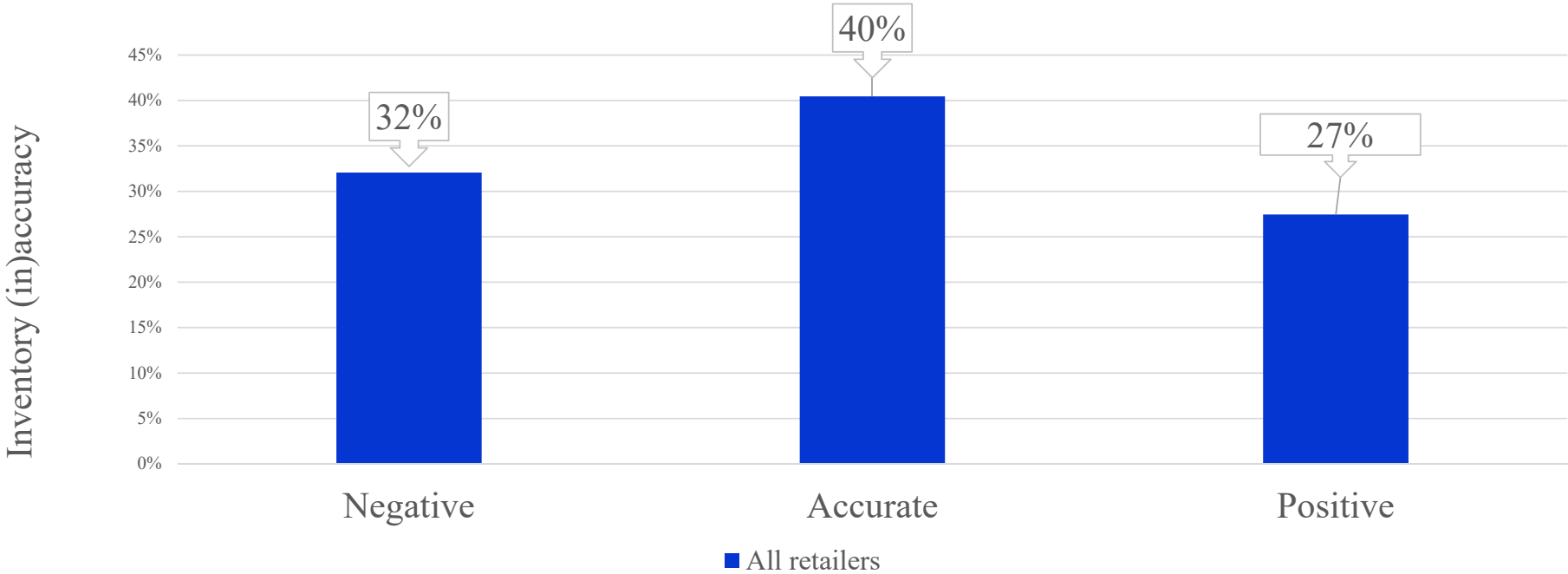
# Result 1: Inventory record inaccuracies constitute an important issue

Independent of the experimental setting, inventory record inaccuracies are an important issue for all participating companies: across all retailers, approx. 60% of the audited SKUs are subject to inaccuracies even if a stock take is performed very frequently



# Result 1: Inventory record inaccuracies constitute an important issue

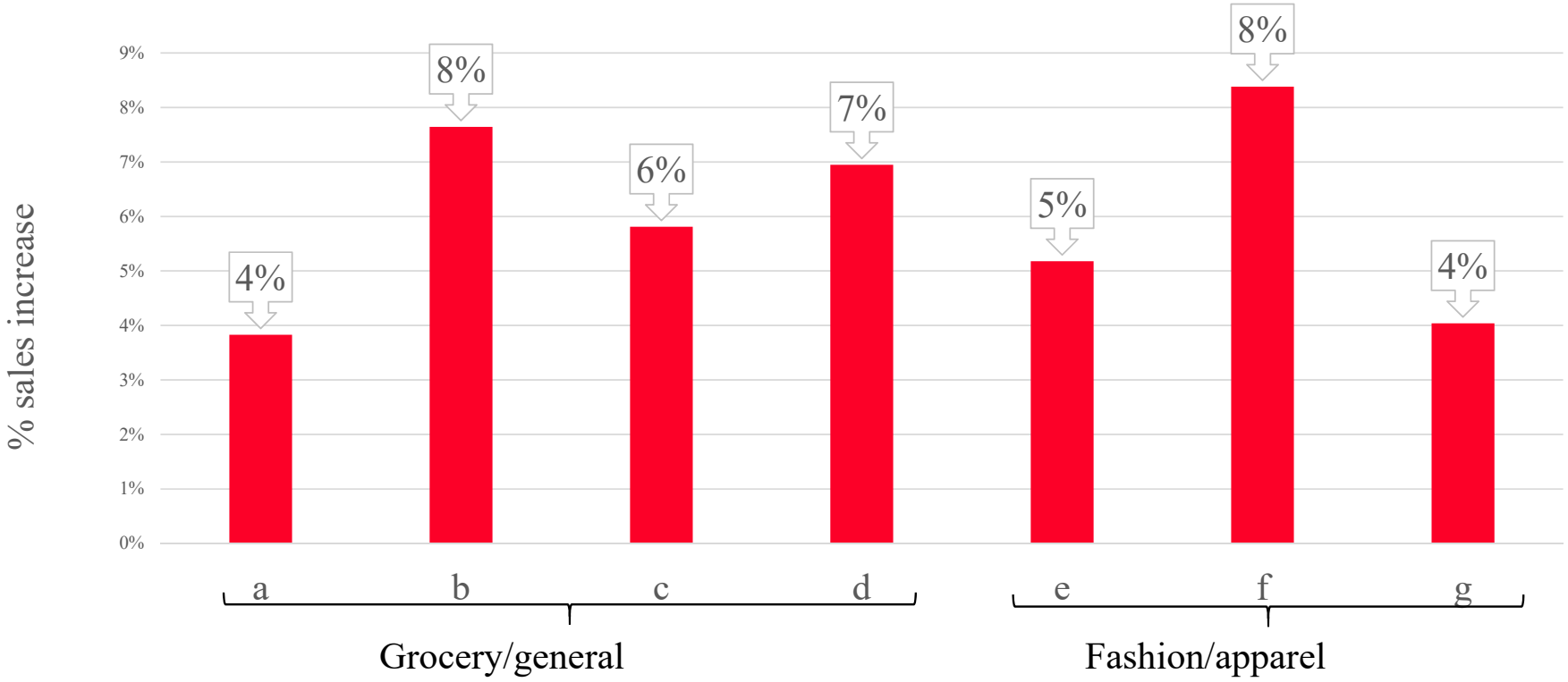
It is not only a matter of shrinkage: positive discrepancy is not negligible and generally is caused by Information System (IS) manipulations and errors



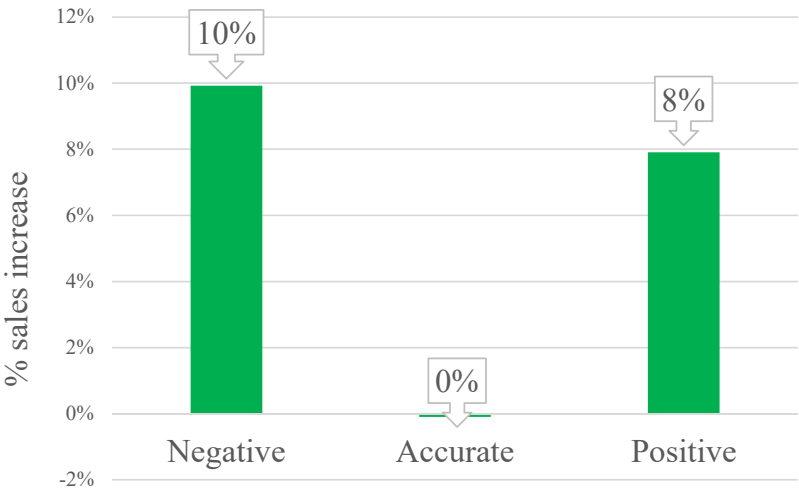
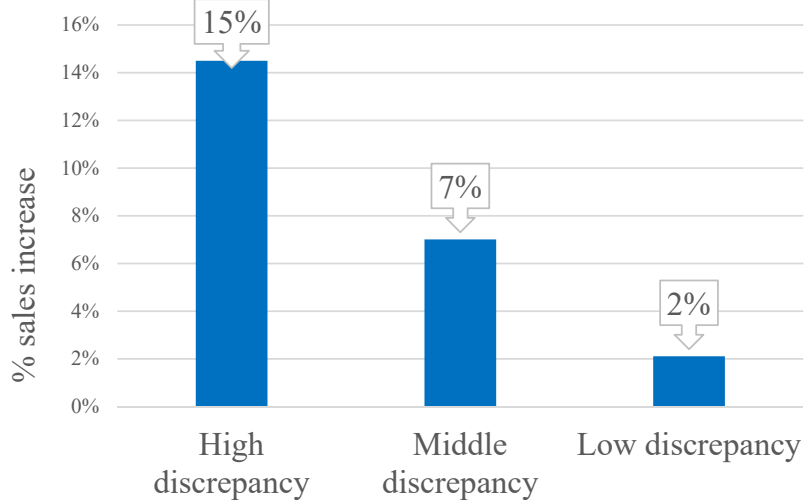
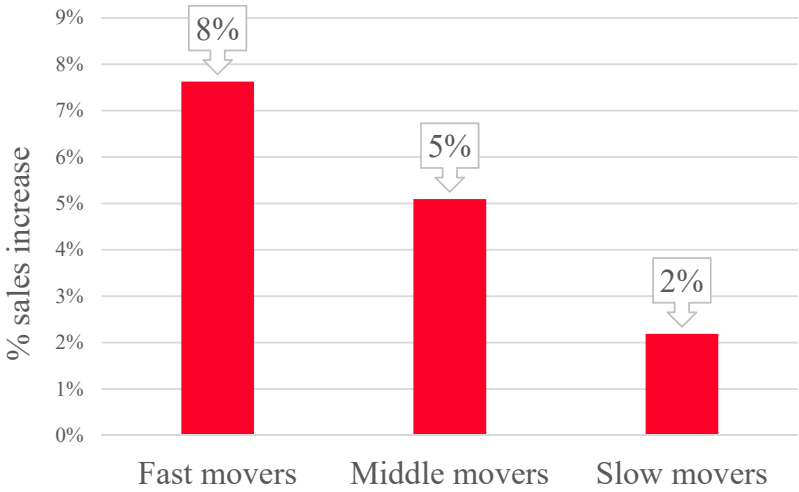
\* We did not apply a discrepancy range in this analysis.

# Result 2

Improving inventory record accuracy leads to an increase in sales between 4% and 8% at the retailers with an average of **6%**



# Sales increase of 6% in the Test stores comes from:

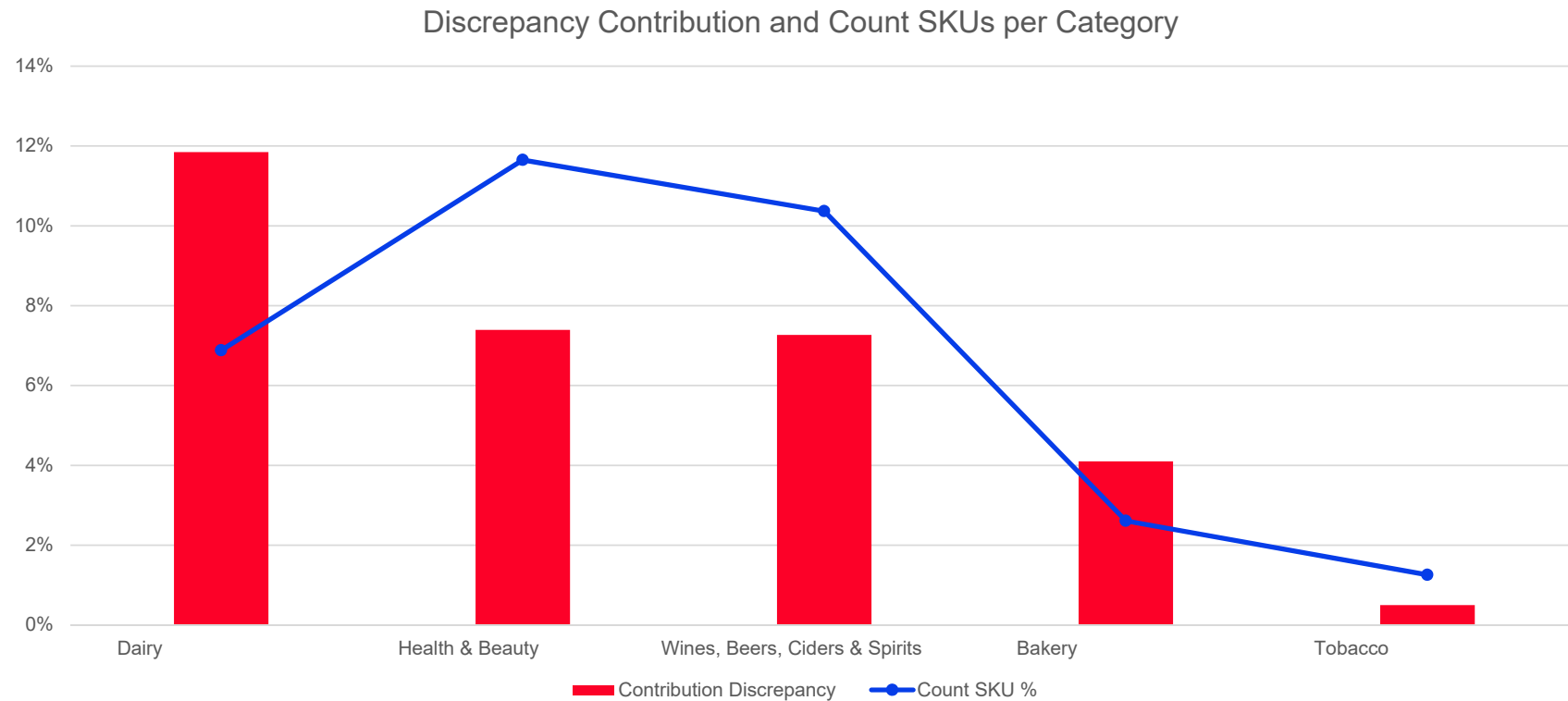


**Fast movers:** 15% of items contributing to 70% of turnover (in value).

**High discrepancy:** 15% of items contributing to 70% of discrepancies (in value).

## Retailer d: Inaccuracy level per category

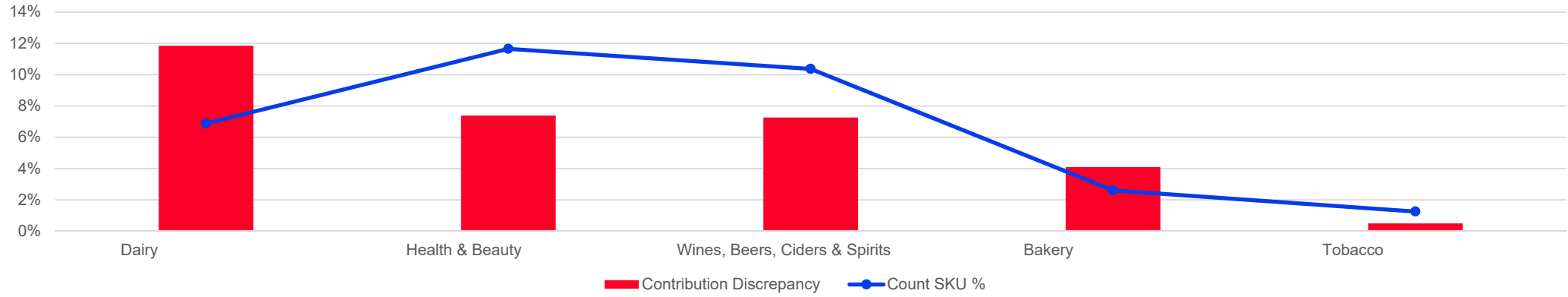
- SKU Categories subject to discrepancies



- The higher the number of SKUs a department has to handle, the higher the discrepancy level is

# Retailer d: Sales increase per category

Discrepancy Contribution and Count SKUs per Category



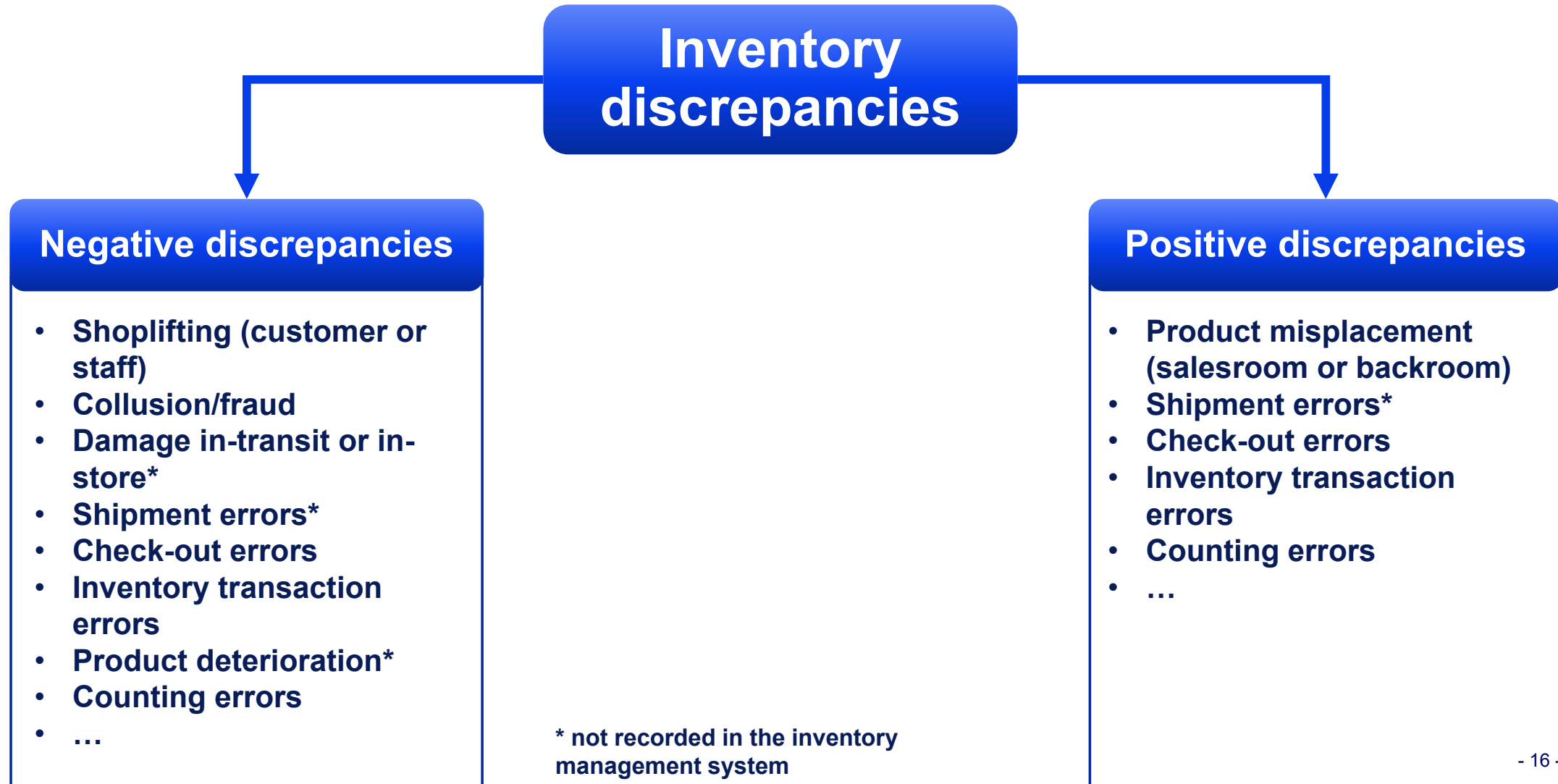
Sales increase



### **PART II: IRI DRIVERS**

## IRI Drivers – Temporary Shrinkage & Transaction Errors

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## **Phase II**

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### **PART III: Next Steps**

# Inventory Record Inaccuracy (IRI)

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## ■ **|IRI|** ←

- + sales volume
- item cost
- monetary volume
- external distribution channel
- + inventory density
- + product variety
- audit frequency

Country, Retail sector

Store context: demographic & sociographic factors

Product category or segment

Other product attributes, e.g., perishability, weight, size

**Based on results for annual  
physical inventory in 37  
stores of the same firm**

DeHoratius and Raman (2008). Management Science 54(4).

## Effect on Sales

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### ■ Sales ←

– |IRI|

Problematic, since IRI is unobservable until an audit takes place

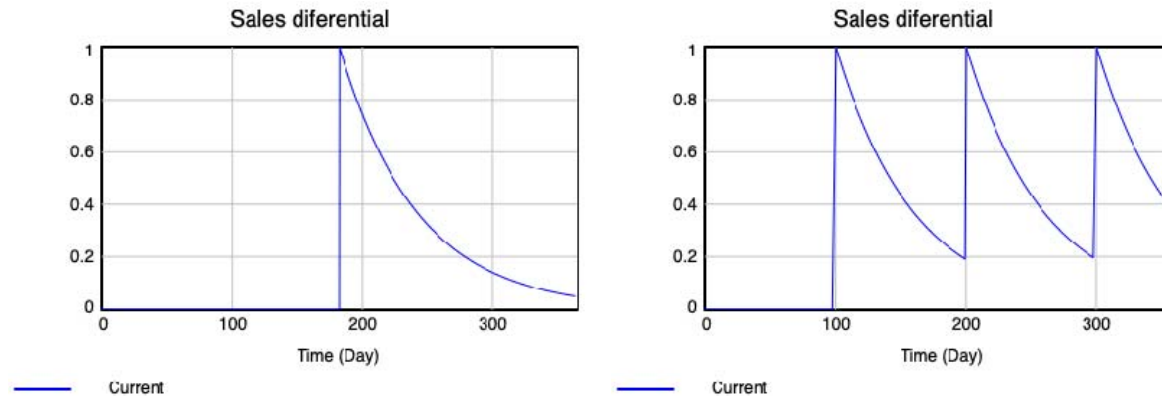
An audit detects that there is IRI, but not when it first started

### ■ Sales ←

+ Audit

## Duration of effects of audits

- From previous work, we know that information accuracy decays exponentially (Chuang et al. 2016)
- The expected benefit from an audit will erode over time



- What is the optimal frequency of audits?
- What is the optimal grouping for an audit?
- Is a continuous auditing policy (a constant fraction of SKUs audited every day) justifiable?

## **For discussion**

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- **What are the implications of our findings for your organisation?**
- **How could you operationalise our insights?**
- **What would you like to see addressed in Phase 2 of the project?**