

Understanding Biases in IR systems on E-commerce Marketplaces

Saptarshi Ghosh

Indian Institute of Technology Kharagpur

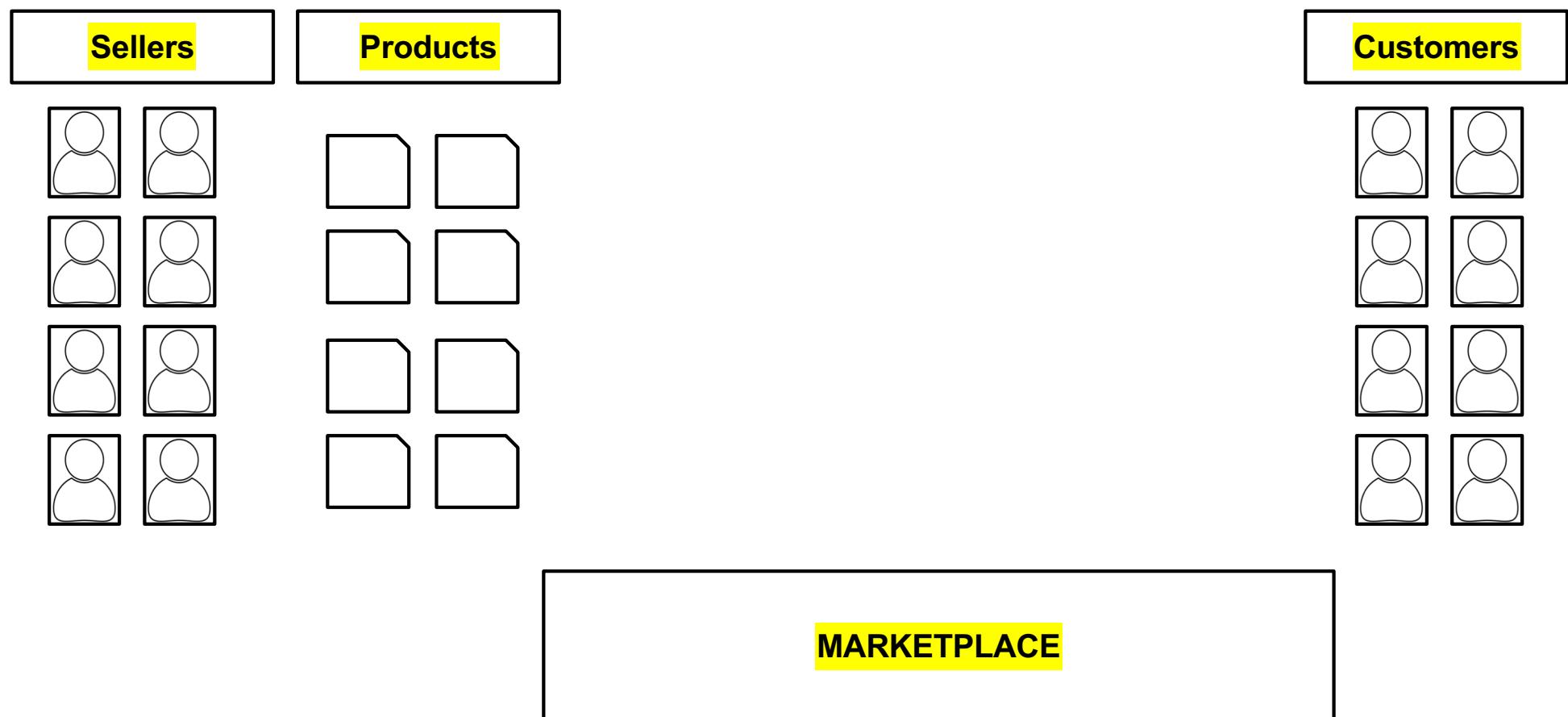
E-commerce marketplace

- ❖ Customers increasingly turning to e-commerce marketplaces for purchase needs.
- ❖ Sellers and producers rely on e-commerce marketplaces for their livelihood.

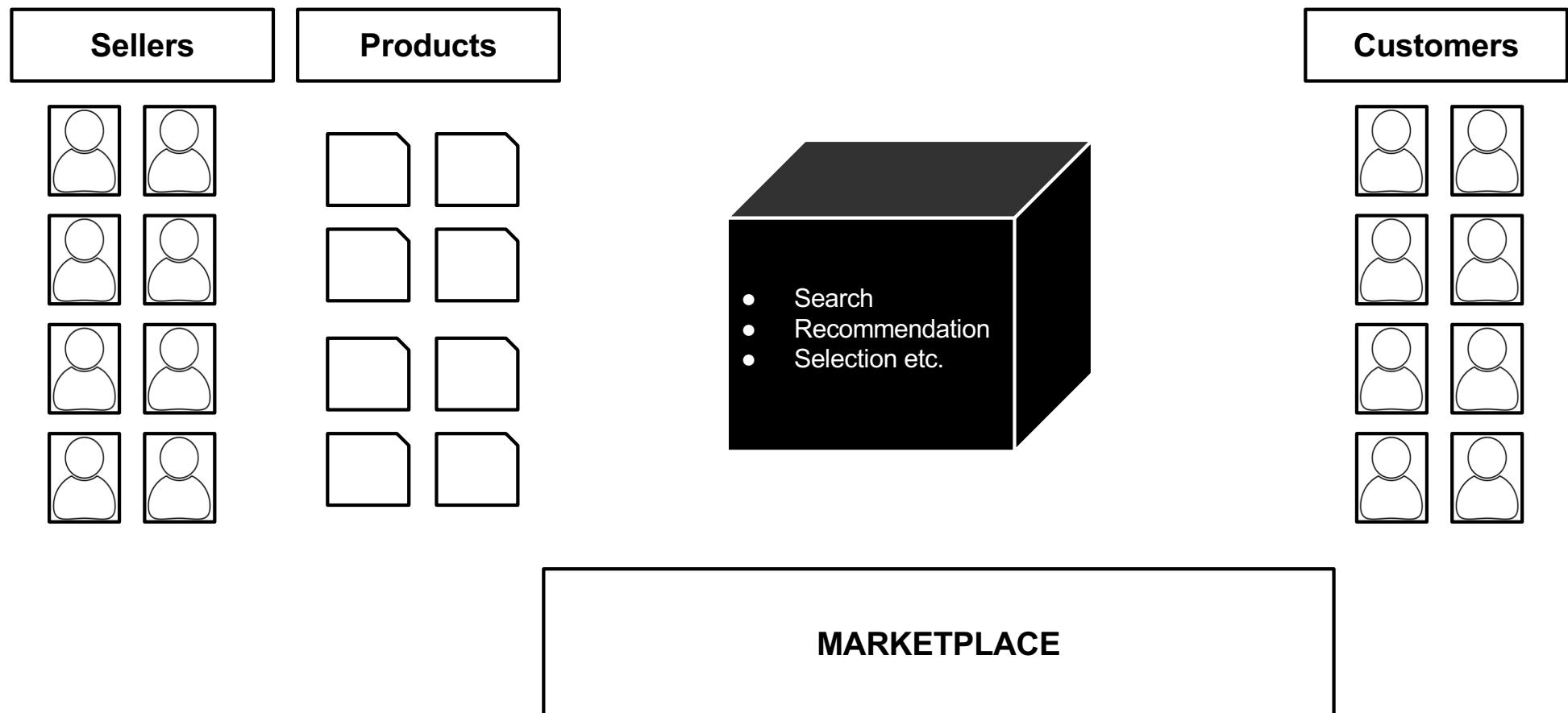


I will use the terms 'marketplace' and 'platform' interchangeably.

Stakeholders on e-commerce marketplaces



Algorithms mediate interactions between stakeholders



IR research

- ❖ Traditionally keyed to
 - Relevance
 - Customer satisfaction etc.

IR research

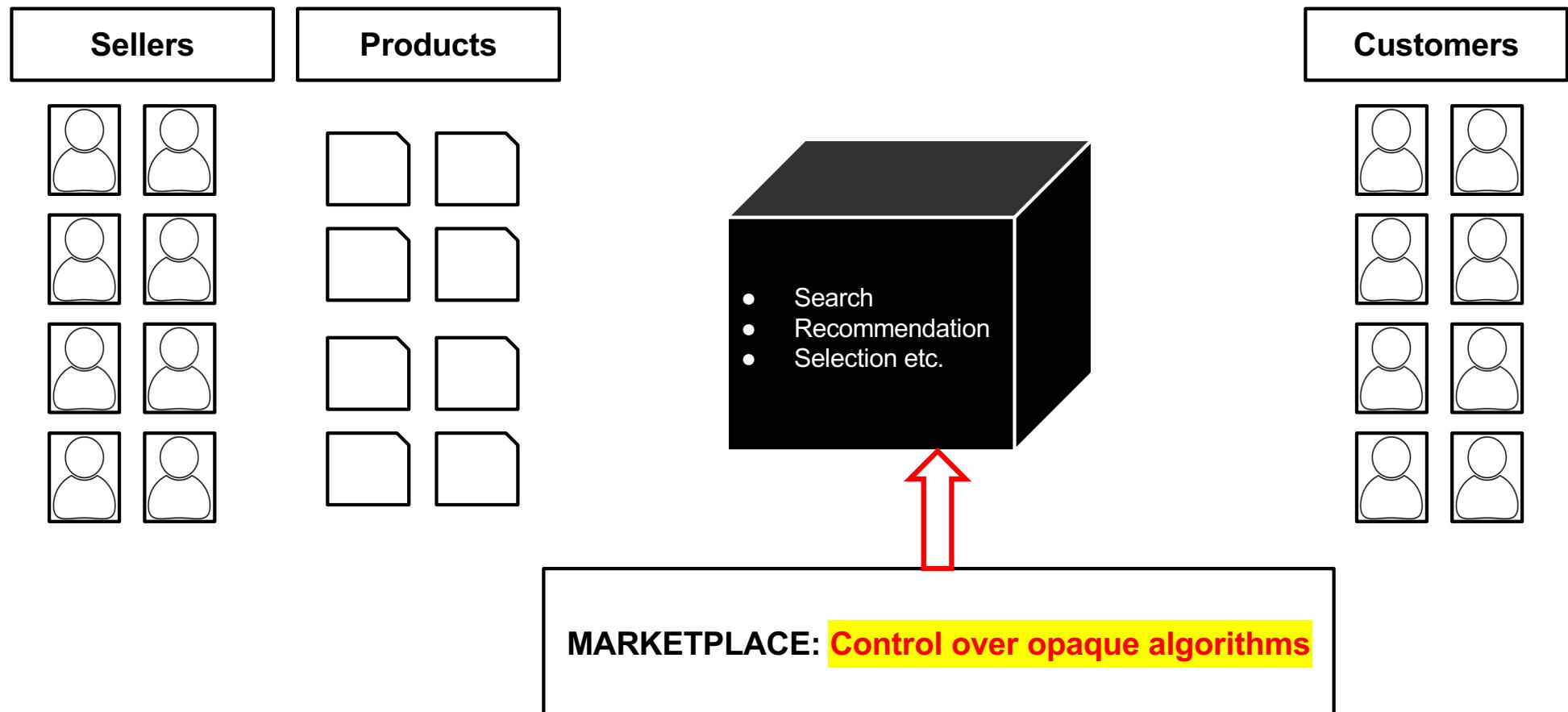
- ❖ Traditionally keyed to
 - Relevance
 - Customer satisfaction etc.
- ❖ Beyond relevance
 - Fairness to customers (e.g., equal satisfaction across demographics)
 - Fairness to sellers (e.g., equal exposure across seller groups)

IR research

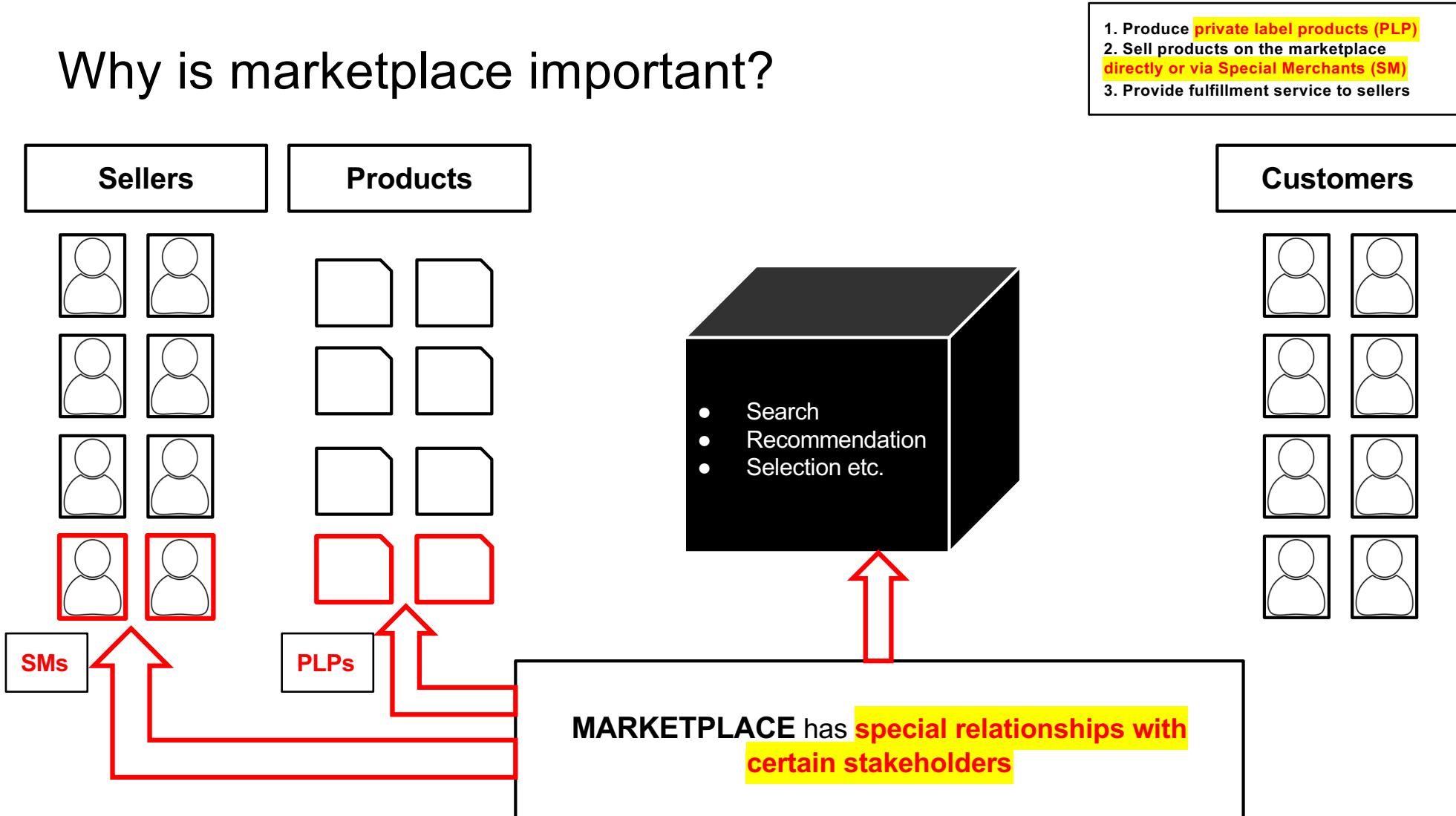
- ❖ Traditionally keyed to
 - Relevance
 - Customer satisfaction etc.
- ❖ Beyond relevance
 - Fairness to customers (e.g., equal satisfaction across demographics)
 - Fairness to sellers (e.g., equal exposure across seller groups)

Another important stakeholder: the Platform / Marketplace itself

Why is marketplace important?



Why is marketplace important?



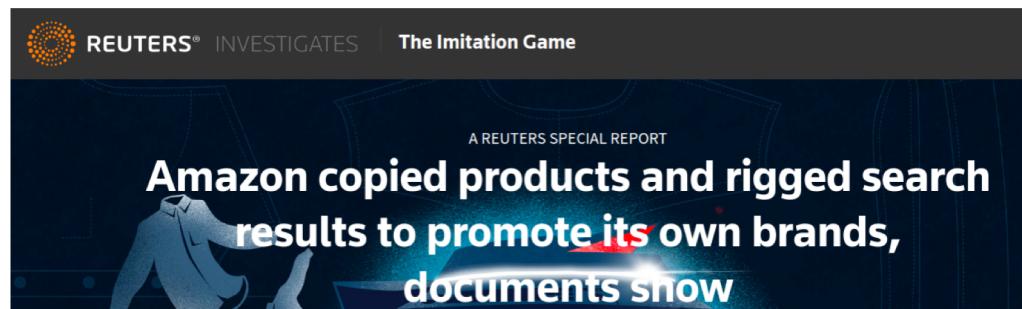
Why is marketplace important?

- ❖ Control over opaque algorithms
- ❖ Has special relationships with certain other stakeholders
 - Private label products
 - Selling products on their own or through Special Merchants
 - Providing fulfillment service to sellers
- ❖ Ability to collect swaths of data on all stakeholders and their activities

Concerns raised in popular press

The New York Times

How Amazon Steers Shoppers to Its Own Products



Policymakers across the globe are equally concerned



[HOME](#) [ABOUT](#) [COMMITTEE ACTIVITY](#) [MEDIA CENTER](#) [ISSUES](#) [SUBCOMMITTEES](#) [LETTERS](#) [CONTACT](#)

Ministry of Commerce & Industry

Digital Markets Investigation

**Antitrust Investigation of the Rise and Use
of Market Power Online and the Adequacy
of Existing Antitrust Laws and Current En-
forcement Levels**

Review of policy on Foreign Direct Investment (FDI) in e-commerce

Posted On: 26 DEC 2018 5:25PM by PIB Delhi

European Commission - Press release



**Antitrust: Commission sends Statement of Objections to Amazon for the
use of non-public independent seller data and opens second investigation
into its e-commerce business practices**

Need of the hour

Except media reports raising concerns based on anecdotal evidences, there is no detailed public scrutiny of these practices.

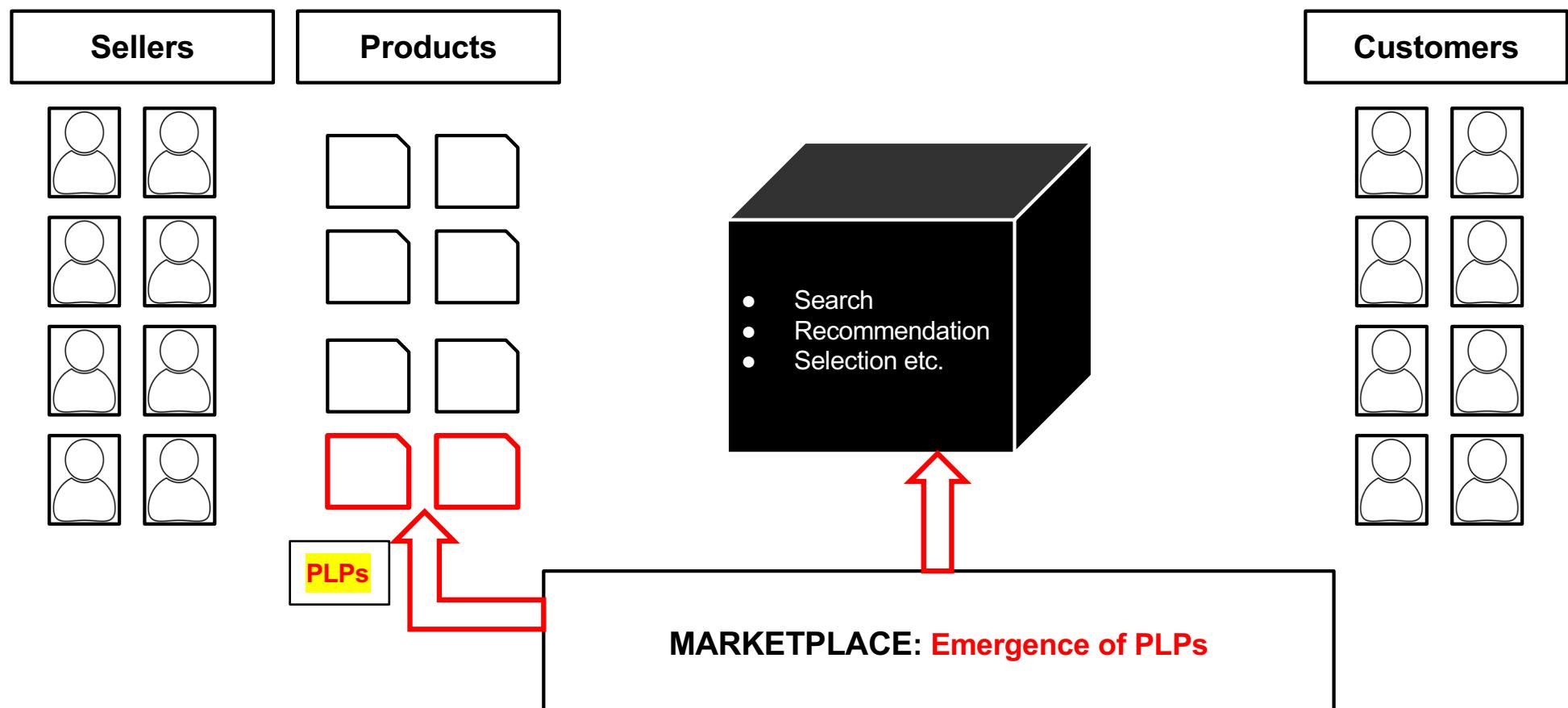
We need a systematic end-to-end audit of the e-commerce ecosystem

Bias in sponsored recommendations: A case study on Amazon

- A first of its kind systematic audit

Why is marketplace important?

PRIVATE LABEL PRODUCTS (PLPs)



Third party products (3P)



Duracell Ultra Alkaline AA Battery, 8

Pieces

Brand: Duracell

4.5 ★★★★☆ 7,145 ratings

| 504 answered questions

#1 Best Seller in General Purpose Batteries & Battery Chargers

M.R.P.: ₹294.00

Deal Price: ₹ 279.00 ✓Prime

You Save: ₹ 15.00 (5%)

Inclusive of all taxes

FREE delivery: Tomorrow

Order within 3 hrs and 15 mins Details



Save Extra with 4 offers

Bank Offer (3): Get 5% up to Rs. 1500 Instant Discount on Standard Chartered Bank Credi... | See All

- Many products from different 3P brands are sold on Amazon e.g., Duracell.

Third party products (3P) Vs. Amazon private labels (PL)



Duracell Ultra Alkaline AA Battery, 8 Pieces

Brand: Duracell 4.5★ 7,145 ratings | 504 answered questions

#1 Best Seller in General Purpose Batteries & Battery Chargers

M.R.P.: ₹294.00
Deal Price: ₹ 279.00 ✓Prime
You Save: ₹ 15.00 (5%)
Inclusive of all taxes

FREE delivery: Tomorrow
Order within 3 hrs and 15 mins [Details](#)

Save Extra with 4 offers

Bank Offer (3): Get 5% up to Rs. 1500 Instant Discount on Standard Chartered Bank Credit Cards | [See All](#)



AmazonBasics AA Performance Alkaline Non-Rechargeable Batteries (8-Pack) - Appearance May Vary

by AmazonBasics 4.5★ 78,568 ratings | 366 answered questions

Amazon's Choice for "aa battery pack"

M.R.P.: ₹446.00
Price: ₹ 249.00 ✓Fulfilled by FREE Delivery on orders over ₹ 499.00 . Details
You Save: ₹ 196.00 (44%)
Inclusive of all taxes

Delivery by: Friday, Sep 4 [Details](#)

No-Contact Delivery 10 Days Replacement Amazon Delivered 1 Year Warranty

In stock.
Sold by Cloudtail India and Fulfilled by Amazon.

Size name: AA
AA AAA

- Many products from different 3P brands are sold on Amazon e.g., Duracell.
- Amazon also produces its own PL products under brand names e.g., AmazonBasics.

This study

- This is the first systematic audit of the Amazon ecosystem
 - **Related item recommendations on Amazon**
- We propose a number of network centric measures to quantify biases towards Amazon Private Label Products

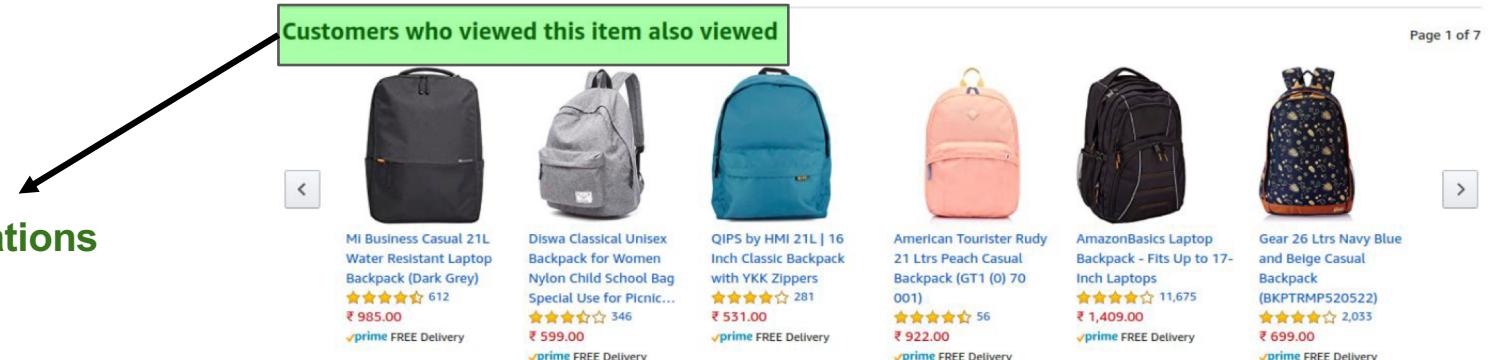
Related item recommendations on Amazon

Sponsored Recommendations



Page 1 of 133

Organic Recommendations



Page 1 of 7

*Screenshot taken from Amazon.in.

Types of products recommended on Amazon

Sponsored products related to this item

Page 1 of 133



Amazon Private Label products (PL)

Customers who viewed this item also viewed

Page 1 of 7



*Screenshot taken from Amazon.in.

Types of products recommended on Amazon

Sponsored products related to this item

Page 1 of 133



Third party products (3P)

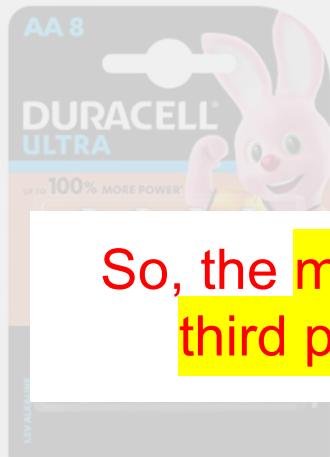
Customers who viewed this item also viewed

Page 1 of 7



*Screenshot taken from Amazon.in.

Third party products (3P) Vs. Amazon private labels (PL)



Duracell Ultra Alkaline AA Battery, 8
Pieces
Brand: Duracell
★★★★★ 7,145 ratings
| 504 answered questions
#1 Best Seller in General Purpose Batteries & Battery Chargers
M.R.P.: ₹ 294.00



AmazonBasics AA Performance Alkaline Non-Rechargeable Batteries (8-Pack) - Appearance May Vary
by AmazonBasics
★★★★☆ 76,568 ratings | 366 answered questions
Amazon's Choice for "aa battery pack"
M.R.P.: ₹ 448.00
Price: ₹ 249.00 Fulfilled by FREE Delivery on orders over ₹ 499.00 - Details
You Save: ₹ 196.00 (44%)
Inclusive of all taxes
Delivery by: Friday, Sep 4 Details

So, the marketplace (Amazon) is in direct competition with other third party (3P) manufacturing brands on its own platform.

- Many products from different 3P brands are sold on Amazon e.g., Duracell.
- Amazon also produces its own PL products under brand names e.g., AmazonBasics.

Concerns regarding sponsored ads

- ❖ Sponsored advertisements replacing organic recommendations



<https://www.marketplacepulse.com/articles/amazon-is-replacing-product-suggestions-with-ads>

Concerns regarding sponsored ads

- ❖ Sponsored advertisements replacing organic recommendations
- ❖ Survey of 2,000+ Amazon customers show that 50% respondents didn't even realize being advertised to on Amazon product pages.
- ❖ Sponsored recommendations offer a powerful option to nudge customers.

<https://www.cnbc.com/2019/07/17/how-amazon-advertising-works.html>

Concerns regarding sponsored ads

- ❖ Sponsored advertisements replacing organic recommendations
- ❖ Survey of 2,000+ Amazon customers show that 50% respondents didn't even realize being advertised to on Amazon product pages.
- ❖ Sponsored recommendations offer a powerful option to nudge customers.

Thus biases in the sponsored ads can not be neglected

This study

- This is the first systematic audit of the Amazon echo-system
 - **Related item recommendations on Amazon**
- We propose a number of network centric measures to quantify biases
 - **Toward Amazon private label products**
- **Specifically, we investigate for biases (if any) in the sponsored recommendations on Amazon**

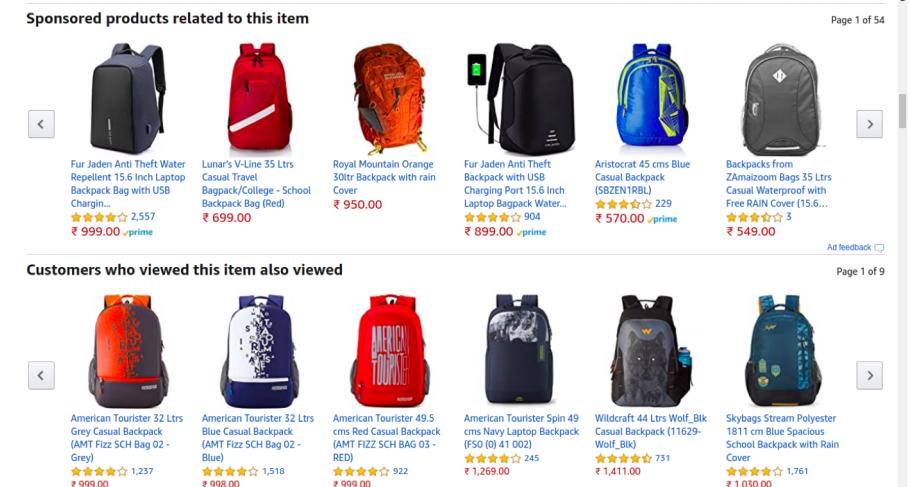
Data collection

- ❖ Categories: Backpack and Battery

Data collection

- ❖ Categories: Backpack and Battery
- ❖ We crawled the Amazon website for data collection.
- ❖ The recommendations and metadata for each products were collected.
- ❖ Both organic and sponsored recommendations were collected.

Category	# Items	#PLs
Backpack	10,775	161
Battery	5,352	17

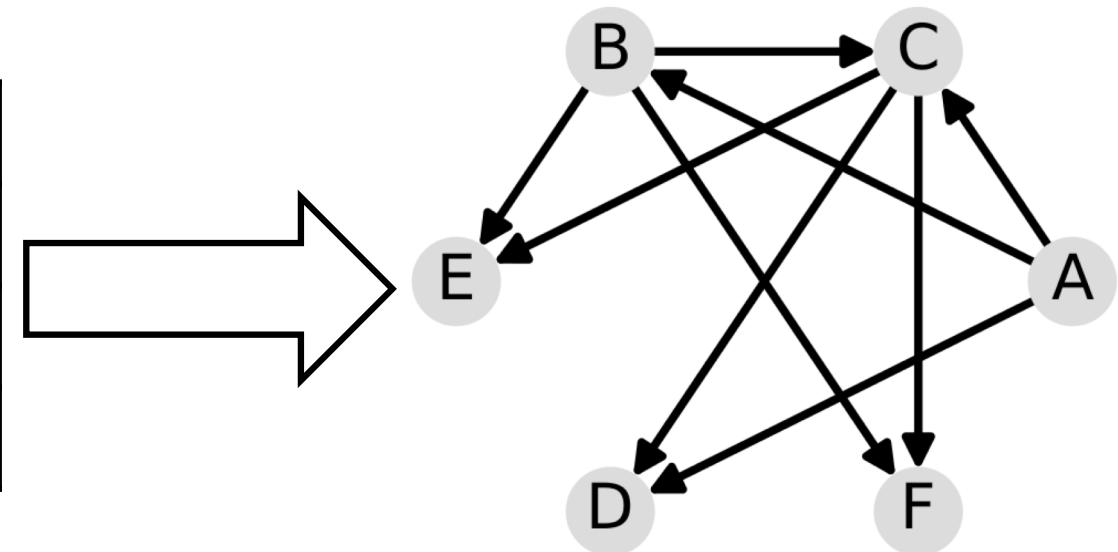


Framework for auditing recommendation systems

The framework

- ❖ To understand the recommendation ecosystem, we instantiate related item recommendations as **Related Item Network (RIN)**.

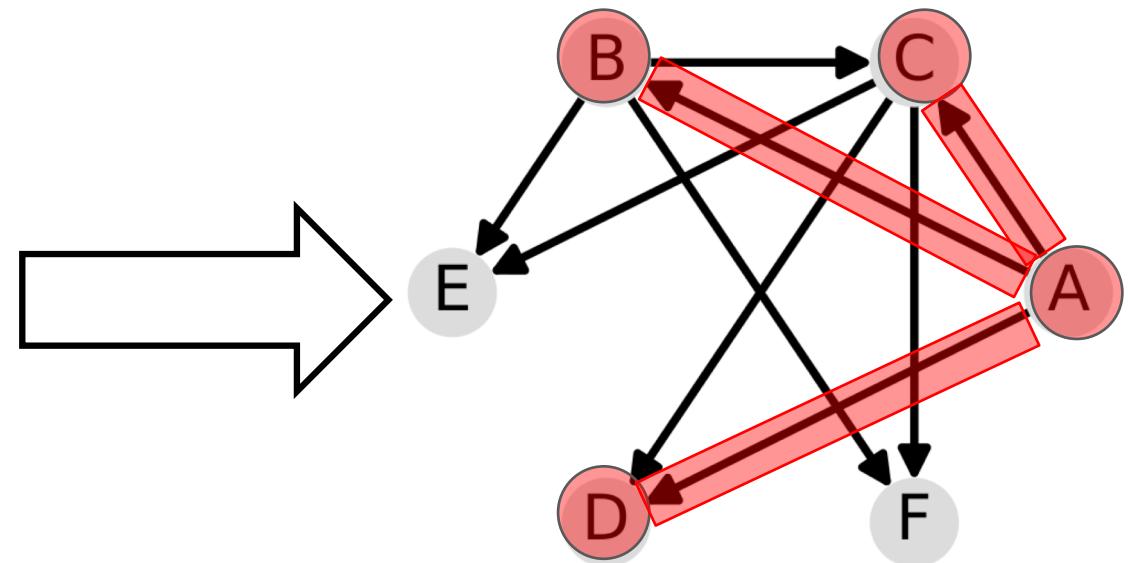
Items	Related items
A	B, C, D
B	E, C, F
C	D, E, F



The framework

- ❖ To understand the recommendation ecosystem, we instantiate related item recommendations as **Related Item Network (RIN)**.

Items	Related items
A	B, C, D
B	E, C, F
C	D, E, F



Two RINs

- ❖ RINs constructed from
 - Sponsored recommendations: Sponsored RIN (S)
 - Organic recommendations: Organic RIN (O)

Two RINs and the rationale behind it

- ❖ RINs constructed from
 - Sponsored recommendations: Sponsored RIN (S)
 - Organic recommendations: Organic RIN (O)
- ❖ Difficult to quantify bias in absolute terms; however it is easier provided an unbiased reference for comparison.

Why two RINs?

❖ RINs constructed from

- Organic recommendations: Organic RIN (O)
- Sponsored recommendations: Sponsored RIN (S)
- Operationalisation of bias: How much does S deviate relative to O
 - How different statistics extracted from S deviate relative to O

Methodologies for evaluation of bias

- ❖ Promotion bias
- ❖ Ranking bias
- ❖ Representation in the core of a network
- ❖ Exposure bias
- ❖ Quantifying the influence of the sensitive attribute

Methodologies for evaluation of bias

- ❖ **Promotion bias**
- ❖ Ranking bias
- ❖ Representation in the core of a network
- ❖ **Exposure bias**
- ❖ Quantifying the influence of the sensitive attribute

Promotion bias

Promotion bias

- Amazon PLs get sponsored recommendations from **half** of the product space.
 - In organic RIN this percentage drops to 15%

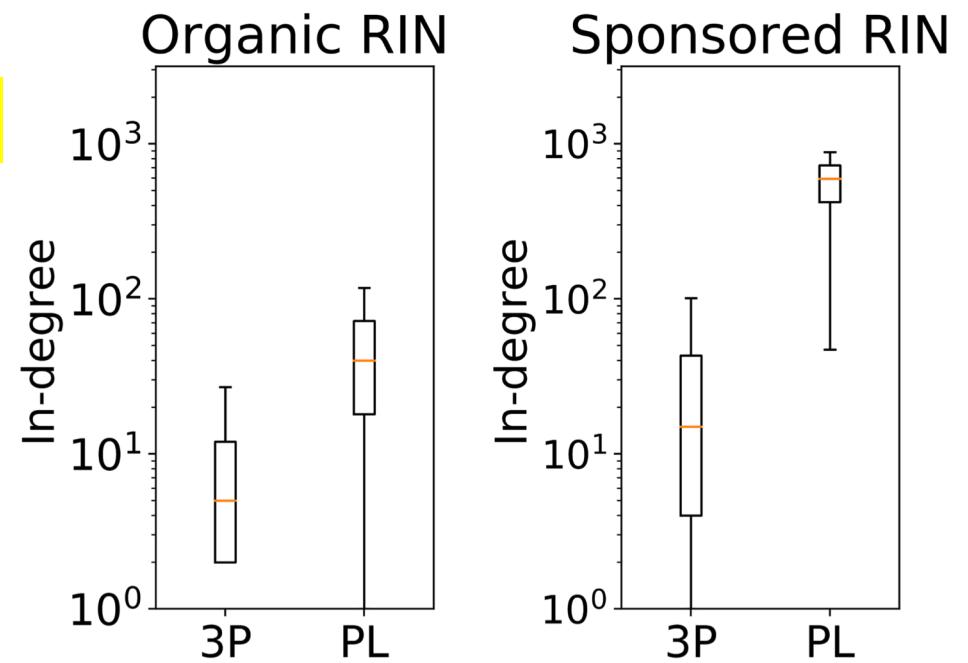
Comparing in-degree of different type of batteries

Properties	Organic RIN	Sponsored RIN
Avg. in-degree of nodes	11	11
Categorization as per products' relationship with Amazon		
Avg. in-degree of private label products	46	520
Avg. in-degree of 3P products	11	09

* All the differences were found to be statistically significant.

Promotion bias

- ❖ Comparison of **in-degree distributions** of different kind of products.

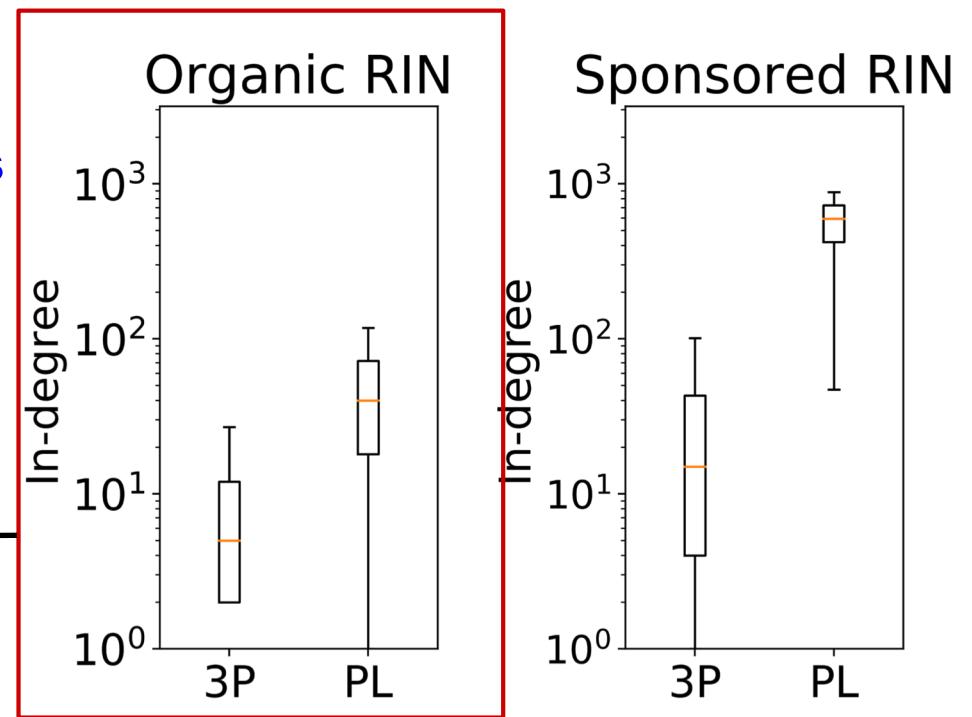


*Y-axes are in log-scale.

Promotion bias

- ❖ Comparison of **in-degree distributions** of different kind of products.

Considerable disparity in the in-degree distributions in the Organic RIN.



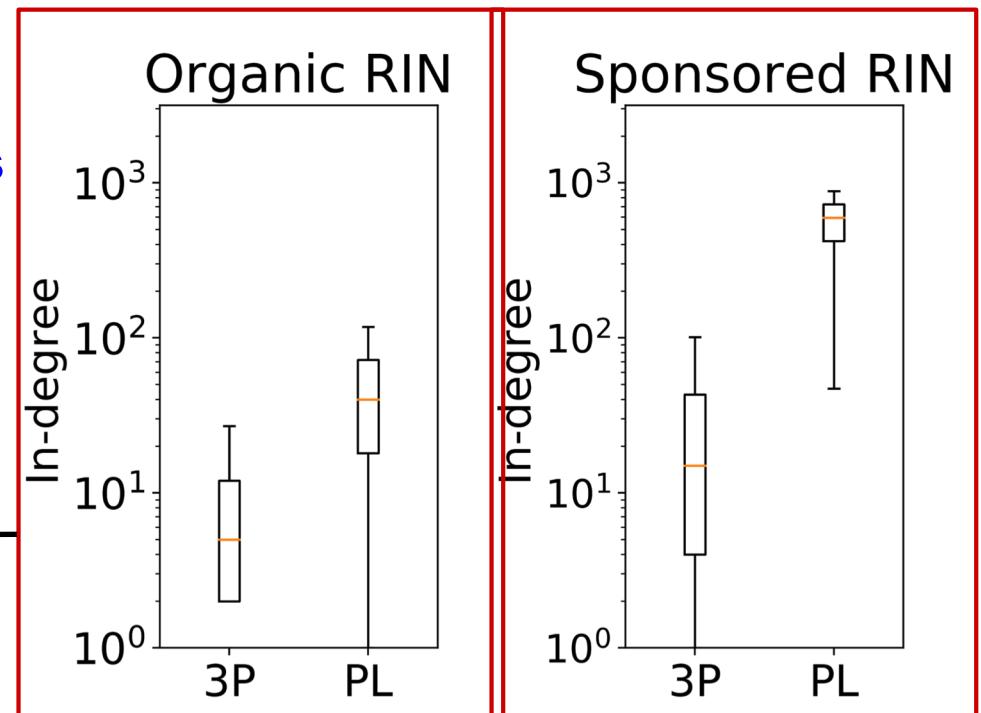
*Y-axes are in log-scale.

Promotion bias

- ❖ Comparison of **in-degree distributions** of different kind of products.

Some disparity

Severe disparity



*Y-axes are in log-scale.

Comparing in-degree of different type of batteries

The degree of promotion of Amazon PLs is significantly higher in the sponsored RIN as compared to organic RIN.

* All the differences were found to be statistically significant.

Exposure bias

Estimating exposure of an item from a RIN

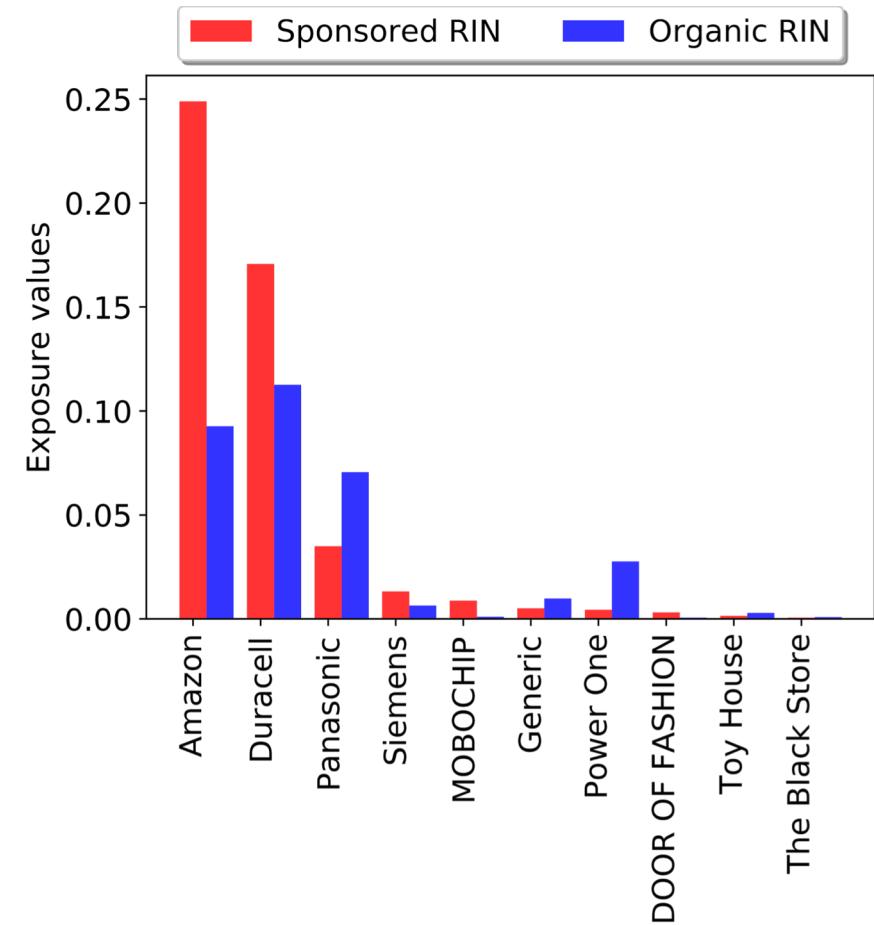
- ❖ We use the ‘Random Surfer Model’ for exposure estimation.
- ❖ The steady state visit frequency of an item on the RIN is its exposure.

Different exposures and exposure bias

- ❖ **Organic exposure:** Exposure of an item due to organic recommendations on Amazon (E_o)
- ❖ **Sponsored exposure:** Exposure of an item due to sponsored recommendations on Amazon (E_s)
- ❖ **Exposure bias** = KLD ($E_s \parallel E_o$)

**Exposure distortion due to
sponsored recommendations**

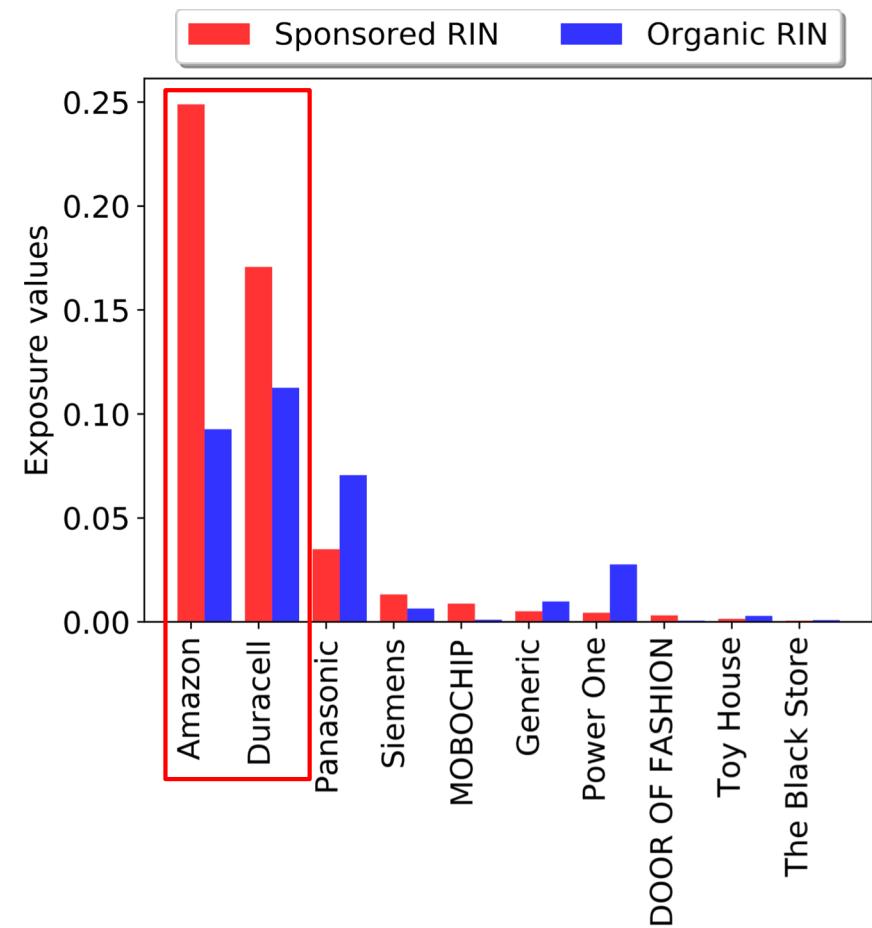
Distortion in exposure for brands on Amazon



Exposure of a brand is evaluated as the sum of exposure of all items of that brand.

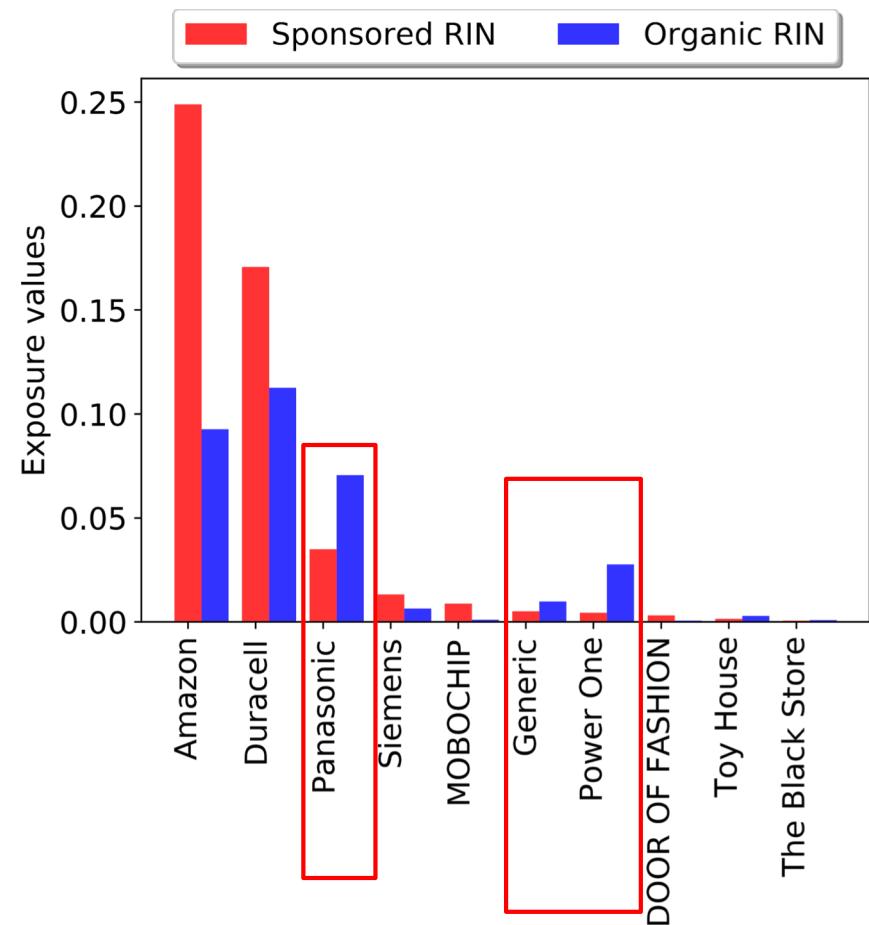
Distortion in exposure for brands on Amazon

- ❖ 17 PLs accounted for **25%** of the total exposure in sponsored RIN.
- ❖ Amazon private label brands and Duracell saw increase in their exposure in the sponsored RIN.



Distortion in exposure for brands on Amazon

- ❖ Top brands like Power One, Generic, and Panasonic saw significant drop in sponsored exposure as compared to their organic exposure.
- ❖ 75% of all brands were underexposed.

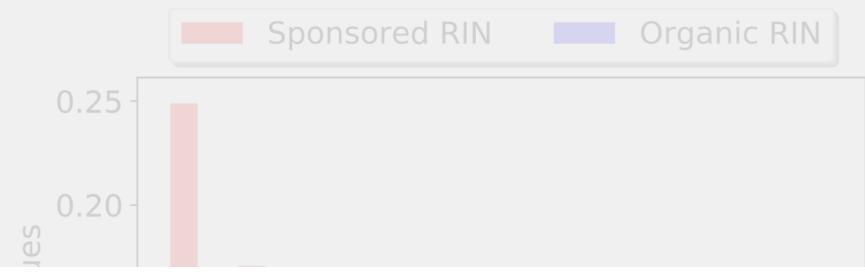


Distortion in exposure for brands on Amazon

❖ Top brands like Power One

Amazon private label products are significantly over-exposed in the sponsored RIN as compared to organic RIN.

underexposed.



Methodologies for evaluation of bias

- ❖ **Promotion bias**
- ❖ Ranking bias
- ❖ Representation in the core of a network
- ❖ **Exposure bias**
- ❖ Quantifying the influence of the sensitive attribute

All the above showed indication of biases toward
Amazon private label products.

Why are biases in sponsored recommendations important?

- ❖ Sponsored Vs. Organic recommendations

- ❖ Economic aspect of self-sponsorship

Why are biases in sponsored recommendations important?

- ❖ Sponsored Vs. Organic recommendations

- Sponsored recommendations ought to be different from organic ones.
 - They can have delayed impact on organic recommendations.

- ❖ Economic aspect of self-sponsorship

Why are biases in sponsored recommendations important?

❖ Sponsored Vs. Organic recommendations

- Sponsored recommendations ought to be different from organic ones.
- They can have delayed impact on organic recommendations.
 - Survey of 2,000+ Amazon customers show that 50% respondents didn't even realize being advertised to on Amazon product pages.
 - Very easy to nudge customers to browse only sponsored products thus affecting the organic recommendations over time

❖ Economic aspect of self-sponsorship

- Amazon can unilaterally reserve ad-space without being accountable.
- This can increase the advertising cost for the remaining ad-space.

Why are biases in sponsored recommendations important?

- ❖ Sponsored Vs. Organic recommendations
- ❖ Hence biases in sponsored recommendations should not go unnoticed.
- ❖ Some clarity regarding the exact practices are also desirable.

↳ Economic aspects of ad sponsorship

- Amazon can unilaterally reserve ad-space without being accountable.
- This can increase the advertising cost for the remaining ad-space.