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An Empirical Analysis of Algorithmic Pricing on Amazon Marketplace

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01 – Objectives

01 Objectives

We analyze the dynamic pricing strategies being used by sellers on Amazon.

Indeed, while algorithmic pricing can help online-shops become more competitive and improve revenue, it also introduces new obstacles.

- poorly built pricing algorithms might interact in unexpected ways and potentially create unexpected consequences

For example, two competing dynamic pricing algorithms mistakenly boosted the price of a secondhand textbook on Amazon to \$23M.

- dynamic pricing algorithms can be used to carry out collusive techniques that are harmful to consumers.

Indeed, the general population is currently unaware of the prevalence and behavior of algorithmic pricing.

01 Objectives

Economic question :

This paper addresses an economic issue since misuse of the price algorithm can lead to collusion and market failure and thus harm consumers.

Indeed, Traditional retailers do not have real-time competitor pricing and are forced to manually re-label the new price of each product.

01.

WHY AMAZON ?

01

Amazon is the largest e-commerce site in the US and Europe

02

Amazon is a marketplace populated by 3rd-party sellers and Amazon itself

03

API provides capability to algorithmic pricing

02 – Data

02. Data

We took data from :

- the top 20 sellers of each product
- every 25 minutes
- during 4 months
- data : prices, ratings and other seller attributes.

Assumption:

Sellers using algorithmic pricing are likely to base their prices at least partially on the prices of other sellers.

Biases :

1. The data is biased toward the most popular products
2. We do not take into account the type of Amazon account used.

03 – Methodology

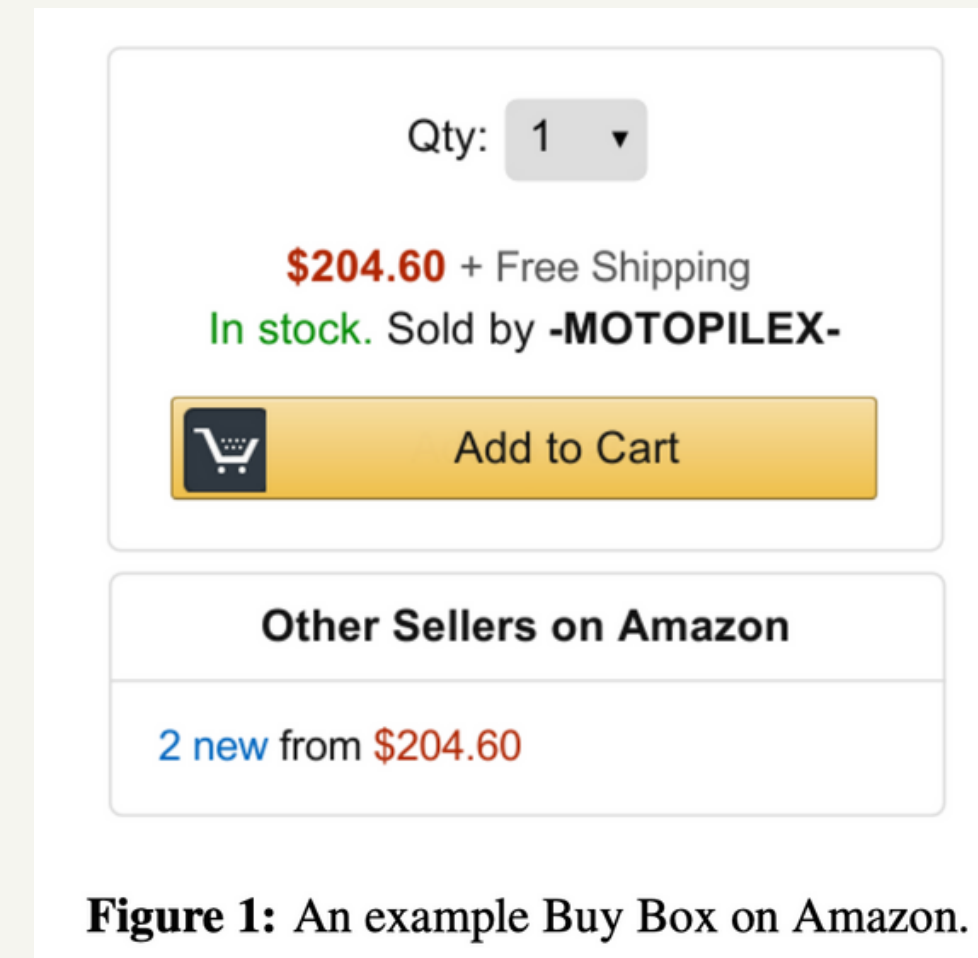
03 Methodology

We estimated a structural model.

objective : they want to analyze the algorithmic pricing strategy of sellers.

And an important criteria to do sales is the Buy Box because 80% of the sales are made through it.

So the we started by understanding the Buy Box algorithm, how it deals with prices, to then analyze the algorithmic pricing strategies.



03.

METHODOLOGY

IN ORDER TO CONDUCT THIS STUDY, WE USED A 3-STEP METHODOLOGY SUPPORTING THE HYPOTHESIS THAT SELLERS USING ALGORITHMIC PRICING ARE LIKELY TO BASE THEIR PRICES AT LEAST PARTIALLY ON THE PRICES OF OTHER SELLERS.

01

Define several target prices that the seller could match against

Three target prices for each product:

- lowest price
- Amazon's price
- the second lowest price.

4 real-time series : $S_r = (t_i, p_i)$, $LOW_r = (t_i, p_i)$, $2NDR = (t_i, p_i)$, $AMZN_r = (t_i, p_i)$

02

Comparison with Spearman's Rank Correlation

Calculate the similarity between S_r and LOW_r , $2NDR$, and $AMZN_r$

They mark these pairs as algorithmic pricing candidates :

- with $\rho \geq 0.7$ (the empirical cutoff of a strong positive correlation)
- and $p\text{-value} \leq 0.05$

03

Filter the candidates

They hypothesize that the more the seller has a high correlation with the target price and makes a large number of price changes then there is a greater chance that the seller will use algorithmic pricing.

threshold ≥ 20

04 – Results

04 Results

1. The number of algorithmic sellers

Table 2 shows a set of sellers that we found to be doing algorithmic pricing

Many more sellers appear to be using the overall lowest price or the second lowest price as the target for their algorithmic pricing than Amazon's price

- > Amazon doesn't sell all products in our dataset
- > Sellers can do different strategies that are not necessarily mutually exclusive

for threshold = 20

543 sellers use algorithmic pricing

it represents 2.4% of all sellers in our dataset

and 38% of all sellers that have ≥ 20 changes for at least one product they sell.

| Strategy | Threshold = 10 | | Threshold = 20 | |
|------------------|----------------|------------|----------------|------------|
| | Sellers | Products | Sellers | Products |
| Lowest Price | 726 | 544 | 426 | 408 |
| Amazon Price | 297 | 277 | 176 | 183 |
| 2nd Lowest Price | 721 | 494 | 425 | 370 |
| Total | 918 | 678 | 543 | 513 |

Table 2: Number of sellers and products with detected algorithmic pricing, based on two different change thresholds. We use a change threshold of 20 unless otherwise stated.

04 Results

2. Price variations

Figure 14 shows an example where a seller (in red) has a clear strategy to always match the lowest price across all other sellers. we can see four other sellers that offer the lowest price over time, and the algorithmic seller (in red) always quickly matches their price.

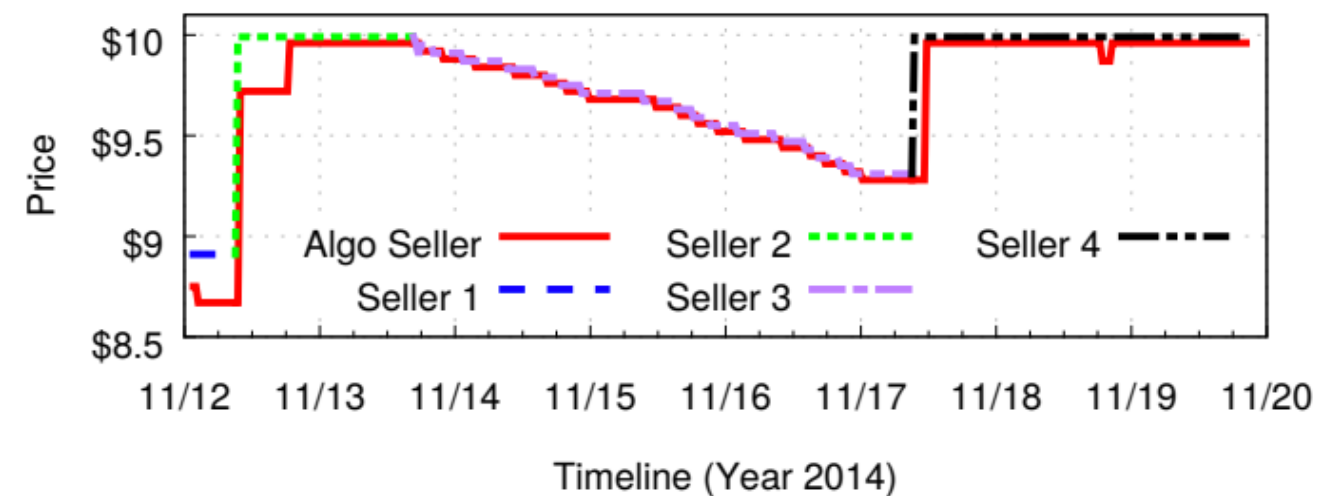


Figure 14: Example of 3P seller (in red) matching the lowest price of all other sellers.

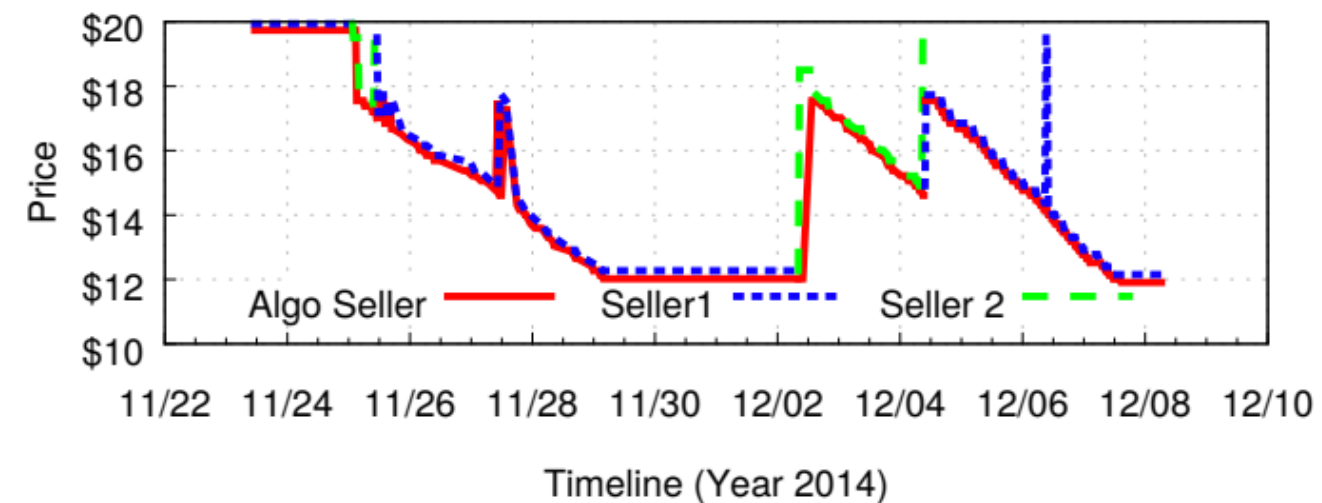


Figure 15: A second example of 3P seller (in red) matching the lowest prices offer by two other sellers.

As shown in Figure 15, the algorithmic seller always matches the lowest price from the other two sellers. Although the algorithmic seller is willing to sell the product for as low as \$12, the majority of the time they sell at prices up to 40% higher.

04 Results

3. Amazon is an algorithmic seller

Amazon itself appears to be employing algorithmic pricing.

In figure 16 we can see that Amazon (in red) is always slightly more expensive than the lowest price, positioning itself like a premium above the lowest price.

But Amazon adopts a more complex pricing strategy than just matching lowest prices. In figure 17, Amazon appears positioning itself as a premium above 9\$ and following the lowest price below 9\$.

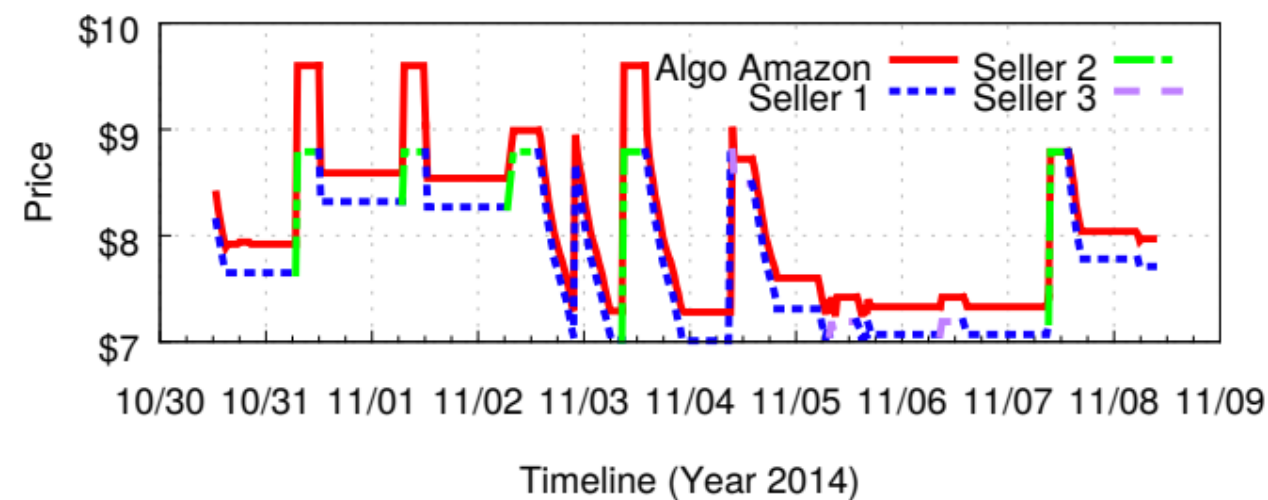


Figure 16: Example of Amazon (in red) setting a premium over the lowest price of all other sellers.

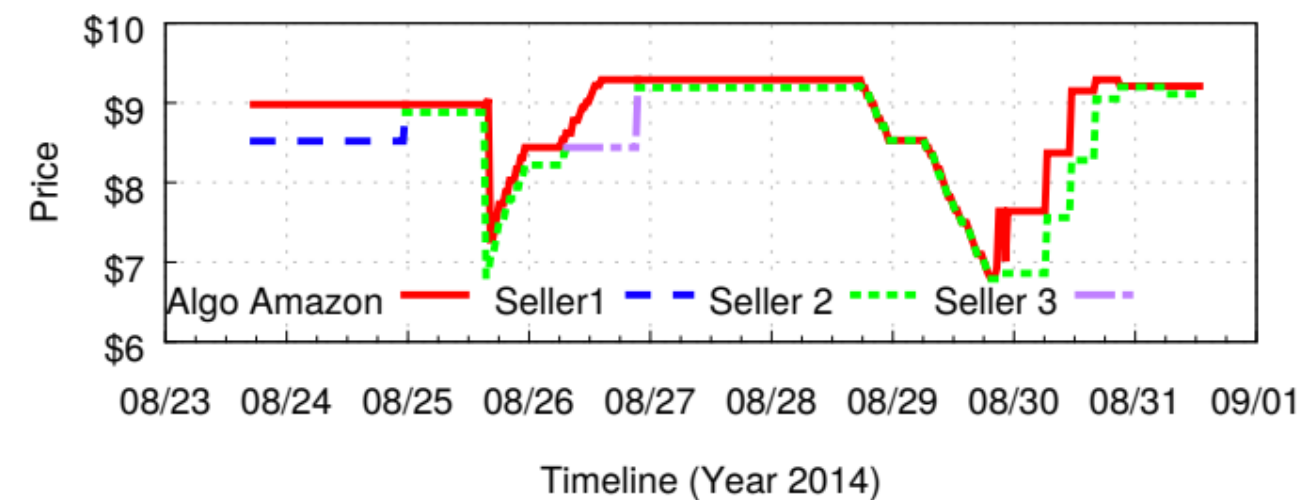


Figure 17: Example of Amazon (in red) matching to the lowest price over time.

04 Results

Then, we analyzed the efficiency of the algorithmic strategy by comparing the characteristics of algorithmic and non-algorithmic sellers.

They observed that algorithmic sellers exhibit significantly different characteristics than non-algorithmic sellers :

- they sell fewer unique products
- they participate in the marketplace for longer periods of time
- they acquire significantly larger amounts of positive feedback (suggesting they may have higher sales volumes)

05 – Conclusions and Discussion

05. Conclusions

1. Algorithmic pricing is powerful :

- algorithmic sellers offer fewer products, but receive significantly higher amounts of feedback (suggesting they have much higher sales volumes)
- also “win” the Buy Box more frequently (even when they do not offer the lowest price for a given product).

2. The Buy Box promotes algorithmic pricing adoption :

- the Buy Box algorithm exacerbates the disparity between algorithmic and non-algorithmic sellers, as it creates a largely winner-take-all marketplace where the Buy Box winner receives the vast majority of sales.

--> Algorithmic pricing can create market distortions

--> We promote long-term monitoring of algorithms in markets for more transparency.

05. Discussions

These variations can be due to a variation in demand.

Indeed, other factors such as the time of year (day/night, winter/summer) or the location (rural/urban) affect demand and sellers know it!

Thank you !