

Some empirical observations on price patterns in online stores

Álvaro Gómez-Losada¹, Néstor Duch-Brown²

¹Department of Quantitative Methods, Universidad Loyola Andalucía, Seville, Spain,

²Digital Economy Unit, Joint Research Centre, European Commission, Seville, Spain.

Abstract

This study aims, through a short experimentation, to empirically identify price patterns in popular products from large online retailers. A set of 35 products and prices were monitored for 15 days, three times per day. Three simple price patterns were identified, and four patterns involving two or more sellers were described. The simple price patterns were Temporary rises and fall of prices, Alternation between two prices, and Ladder steps of prices. Compound pattern prices were Price chasing, Price exchange, Mimic at a lower or similar minimum prices, and Conditioned appearance, most of them described in economic literature. This research does not discuss the use of algorithmic pricing when setting prices by online retailer but it could be involved. Next steps in this research consider to wider the number of analyzed products and to increase the frequency and time of their monitoring.

Keywords: *price patterns; algorithmic pricing; pricing technology; online retailers.*

1. Introduction

Pricing technology has recently attracted the attention of academics, practitioners and regulators. Although the use of pricing algorithms has a long history (Calvano et al., 2020), concerns about algorithmic collusion have only recently emerged due to the increased sophistication of learning algorithms and their propensity to uncover collusive pricing rules.

The literature regarding collusive associations and pricing technology is vast. To cite a few, the degree of synchronization in price changes in online markets was studied by Gorodnichenko & Talavera (2016). Cavallo (2018) studied the online competition based on algorithmic pricing technologies on large retailers using different categories of products. Brown and MacKay (2021) studied the price time series of allergy drugs from five online retailers in the United States, and the reaction to price products among rivals.

This study aims through a short experimentation to empirically identify price patterns in popular products from large online retailers. For that purpose, a set of 35 products and prices were monitored during 15 days. Methodology applied is described in Section 2, and main price patterns identified are described in Section 3. Final conclusions are provided in Section 4.

2. Material and methods

To monitor the progress of prices and detect identifiable patterns, prices from 35 consumer products were observed during 15 days (from 5th February to 20th February 2023) in online market places in Spain, three times per day. Products categories were Electronics (20 products, e.g., Apple Iphone 11 64 GB Black), Home (two products, e.g., Philips Wake-up Light HF3500/01), Kitchen (five products, e.g., Cafetera Bialetti Venus, 6 cups), Toys (four products, e.g., LEGO 71043 Harry Potter Hogwarts Castle Model) and Handicraft (four products, e.g., Fimo Soft Modelling Clay, Lemon, 57 g). Online market places selling these products were obtained from Google Shopping, and later these products located on these markets and the product pages were web-scraped and parsed the resulting html files. Similarly, the same 35 analyzed products were identified in Amazon online store since was not provided by Google Shopping. Then, products were matched in Amazon according to their similar name, characteristics and price of those analyzed products in Google Shopping. A longitudinal database of 12206 observations, and time, product, online seller and price variables were built after processing each product page. Those merchants renting any of the analyzed products were not considered, as well as those product pages in which the price of the product was temporarily hidden. When an online seller was present multiple times (e.g., Fnac and Mediamarkt, which have multiple online shops in Spain) just two online shops were considered, namely, the one closest to the place from where the research was carried out (Seville, Spain) and the one with the lowest price of the product, most of the times coinciding

in price (e.g. uniform pricing) (Cavallo, 2018). Some sellers were found to be associated with other merchants like eBay.

3. Results and discussion

Analyzed products were sold by 156 online sellers, and as expected, the higher frequency of change of process were found in Electronics category (results not shown). Some recurrent dynamic of price changes were analyzed by sellers when selling the same product over time, and some common pattern were detected. Some of these patterns was identified for a single merchant (simple patterns), and in conjunction with others (composite pattern). Most of the observed price patterns can be present individually or in combination. Next is illustrated and described those types of patterns.

3.1. Simple patterns

These patterns were detected in Amazon, asgoodasnew.es, ebay.es and Acelstore, mostly on mobile phones.

(1) **Temporary (and drastic) rises or falls.** This happens when product prices are suddenly risen or dropped to later return at the prior or similar price within hours. In Figure 1 (left), it is illustrated a 46.6% increase in the price of Amazon’s Samsung Galaxy S22 Ultra SM-S908B 17.3 cm. At the center, the price of Sony Playstation 5 Standard Edition - 825GB White was 50.9% raised by ebay.es. In this latter case, prices before and after the rise are different. The magnitude of the rise or drop can be very varied, as in the Figure 1 (right) in the case of Apple iPhone XR Black 64 GB sold by ebay.es, with a 25.2% price drop. This price dispersion in online retailers was described by Duch-Brown & Martens (2014) but in a longer period of time and not on a hourly basis like in this study.

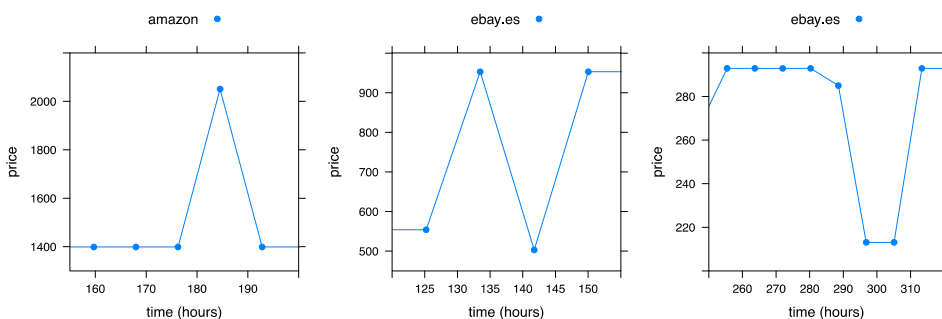


Figure 1. Occasional dizzying rises and falls

(2) **Alternation between two prices.** The price of the Apple iPhone 8 64GB Gray alternates between two set prices, that can vary over time. In Figure 2 (left) the price was set to 260.9€

and 438€ by ebay.es. On the right, and for the same product, asgoodasnew.es set the prices initially at 195€ and 245€, and some hours later at 175€ and 225€. The range of prices is constant in Figure 2 (right).

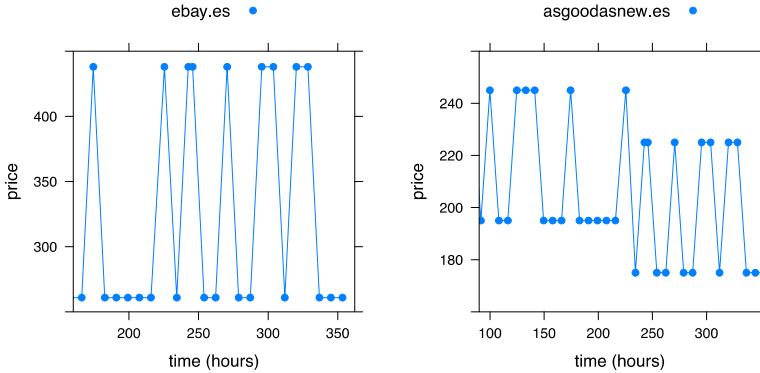


Figure 2. Alternation between two prices

(3) **Ladder steps.** This dynamic reminds the steps of a ladder, with variation in the height and wide (time) of the step. Figure 3 (left) shows this pattern for the Apple iPhone 11 64 GB Black sold by Acelstore. The prices ranged from 317€ to 377€ in three steps, two of them at 327€ and the last one at 333€. At the center, the price of Sony XDRS41DB.EU8 – Portable Digital Radio sold by Amazon begins at 77.99€ and ends at 98.11€, with two intermediate steps at 87€ and 90€.

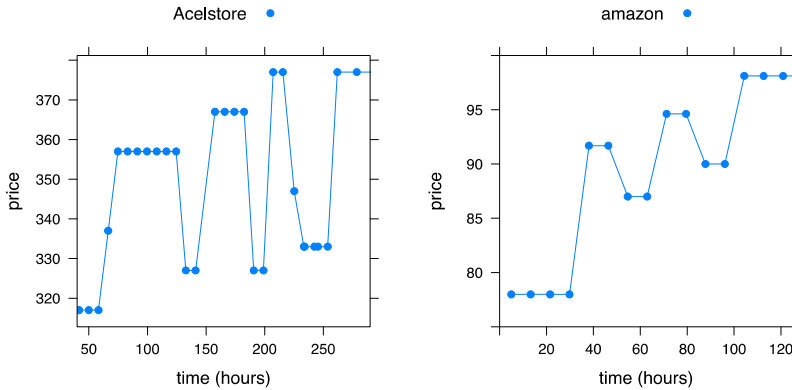


Figure 3. Staircase with different height steps

3.2. Compound patterns

These price dynamics imply at least to two sellers selling the same product, and in some cases can be observed a combination of them, as in the simple patterns.

(1) **Price chasing.** One seller prices like the other seller, or approximately. In Figure 4, Amazon and MediaMarkt price DJI Mini 2 Fly More Combo (Dron) with the same value during 15 days, except at particular occasions, in a raising trend. This trend was no observed in a descending fashion in neither of the products observed in this study. For the sake of clarity, another MediaMarkt shops was omitted in the graph, with the same dynamic as its homologous.

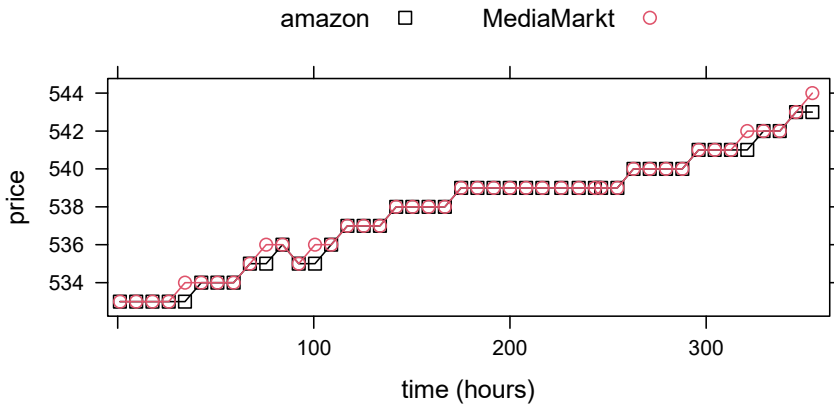


Figure 4. Price chasing

(2) **Price exchange.** Two players exchange the price at a given time. This is illustrated in Figure 5 at prices 959.9€ and 1099€ for the Samsung Galaxy Z Flip4 5g 128GB Grey sold by MediaMarkt and the manufacturer of the mobile telephone.

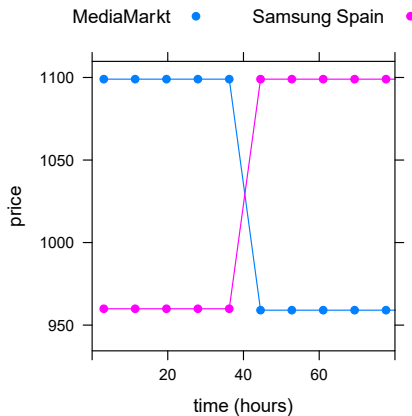


Figure 5. Price exchange

(3) **Mimic at a lower or similar minimum prices.** Two sellers show the same dynamic of prices, but with a different minimum price. In Figure 6 (left), the price for Apple iPhone 8 64GB Gris sold by asgoodasnew.es and ebay.es show different range, but the pattern is similar. One of the seller keep lower prices than the other one. On the right, the difference between the minimum prices for the iPhone 12 128GB Black Apple is lower than in the previous case. This could be referred as a low-price matching practice in literature (Deck & Wilson, 2000). Figure 6 (left) shows a combination of the simple patterns 1 and 3 (Temporary and drastic rises and falls, and ladder steps).

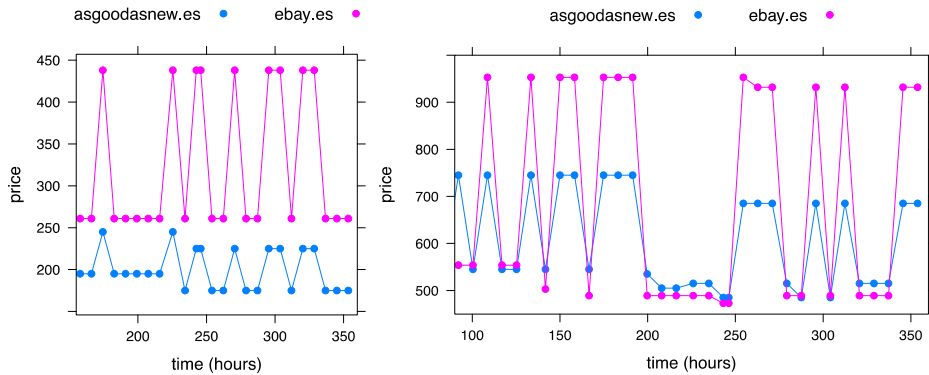


Figure 6. Mimic at different or similar minimum prices

(4) **Conditioned appearance.** The intermittent appearance on some sellers could be conditioned by the presence of other sellers. This could be the case of Fnac, ShopDutyfree.es and Swappie on the Apple iPhone 12 - Black, 128GB. In few occasion the three sellers appear simultaneously.

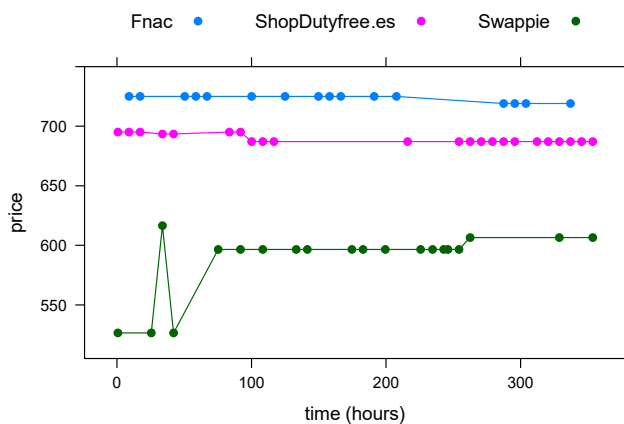


Figure 7. Conditioned appearance

These described patterns are a simple empirical description of the observed price dynamics for some of the selected products for this study. Therefore it is not considered possible causes conditioning such dynamics, as stock status, local seasonal changes, special offers on products, trade rules or collusive agreements among sellers which are difficult to evaluate, to name just a few. Also the human intervention or the automate price-setting using software tools (algorithmic pricing) are not assessed. However, patterns described in this work as the compound pattern 1 (price chasing) make difficult to believe an human decision-maker behind that pattern, given the high frequency of price changes within hours. Sample of products selected for this study are popular, but few in number. In the simple described patterns, more than one example has been chosen to illustrate the price dynamic, however, just one in the case of the compound ones, since it should require to wider the span of the research for finding the compound patterns in repeated occasions to agreed them. Further research includes to extend the observational period of prices, extend the list of products to be observed over time, and increase the observation frequency of prices.

4. Conclusions

This empirical study aimed to describe observational patterns of prices in online platforms. For that purpose, 35 popular products sourced using Google Shopping were scrapped from online market places and monitored during 15 days. Three simple patterns were detected and two examples of each provided (e.g., temporary rises and fall of prices, alternation between two prices and ladder steps of prices). Besides, four price patterns implying two or more sellers were also described (e.g., price chasing, price exchange, mimic at a lower or similar minimum prices and conditioned appearance). Given the high frequency of price changes observed, it seems algorithmic pricing could be operating on price decisions. Next steps in this research consider to wider the number of analyzed products and to increase the frequency and time of their monitoring.

References

- Brown, Z.Y., & MacKay, A. (2021). Competition in pricing algorithms. *American Economic Journal: Microeconomics* (forthcoming). Working paper. SSRN. Available at: <https://ssrn.com/abstract=3485024>.
- Cavallo, A. (2018). More Amazon effects: online competition and pricing behaviours. NBER Working Paper No. 25138.
- Calvano, E. et al. (2020). Protecting consumers from collusive prices due to AI. *Science*, 370, (6520), 1040-1042.
- Deck, C.A., & Wilson, B.J. Interactions of automated pricing algorithms: an experimental investigation, in *Proceedings of the 2nd ACM Conference on Electronic Commerce*, 77–85.

- Duch-Brown, N., & Martens. B. (2104). Consumer benefits from the EU Digital Single Market: Evidence from household appliances markets. JRC Technical Reports. Digital Economy Working Papers 2014/03. JRCB9991.
- Gorodnichenko, Y., & Talavera (2017). Price setting in online markets: basic facts, international comparisons, and cross-border integration, *American Economic Review*, 107, 249–282.