Price Discrimination under Minimum Advertised Price Restriction *

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Abstract

A minimum advertised price (MAP) policy is a popular vertical restraint. We study retail pricing under MAP using price data of Seagate hard disk drives on US online retailers. The data suggest that MAP is not a form of minimum resale price maintenance (RPM). First, we find that retail prices can be significantly lower than MAP. Second, retail prices of products subject to MAP have greater dispersions between retailers. Lastly, retail prices sometimes increase after a MAP decrease. These observations are consistent with the predictions of a search model that interprets MAP as a form of information restraint.

JEL Classification: L41, L81, D83

Keywords: search model; vertical restraint; minimum advertised price; resale price maintenance; online retail

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1 Introduction

In this paper, we empirically show that a minimum advertised price (MAP) policy is not a form of minimum resale price maintenance (RPM). MAP allows a manufacturer to restrict the minimum price that retailers advertise publicly on a price comparison website or a retailer's product pages. Retailers remain free to charge any price through negotiations or at checkout. There have been a number of views on the effects of MAP. A traditional view is that MAP and RPM impose similar vertical controls. Specifically, antitrust authorities and courts often do not distinguish MAP from RPM, and the two policies face similar legal challenges.[1] Economic analysis has shown that MAP would be equivalent to RPM if consumers anticipate being charged the advertised price (Asker and Bar-Isaac, 2018). Kali (1998), for example, treats MAP as a minimum resale price with an advertising subsidy. More recently, a different view emerged. Asker and Bar-Isaac (2020) (henceforth AB) point out that, like in Diamond (1971), MAP is an information restraint that impedes consumer search, facilitates price discrimination, and increases profit without directly dictating retail prices. The welfare effect of MAP is theoretically ambiguous in this framework.

Given these views' different antitrust implications, it is important to establish empirical evidence on the effects of MAP and distinguish them from RPM. We use online retail prices of two lines of Seagate hard disk drives, Barracuda and Momentus, to study how MAP differs from RPM. We collect Seagate's publicly available MAP policies, which document each product subject to MAP, the specific dates of the policy, and the dollar values of MAP. We match these policies with daily retail prices of the same products on leading US online retailers from November 2011 to April 2013. In the resulting dataset, there are 9 products subject to MAP ("MAP products") and 23 other Barracuda and Momentus products not subject to MAP ("non-MAP products").

Our empirical analysis presents three results that highlight the differences between MAP and RPM. First, we show that retail prices can often be lower than MAP. Of the nine

[1] We review the historical background on MAP's legality in Section 2. Also see, for example, Hinman and Shah (2008), Romano (2010) and Passo (2015).

products subject to MAP, more than half of the retailer-week observations are below MAP for two products, and more than 30% of the observations are below MAP for seven products. These observations show that MAP, unlike RPM, is not a hard lower bound on retail prices. We also argue that the violations are not likely due to lax enforcement.

Second, we find that retail prices of MAP products are more dispersed than those of non-MAP products. We argue that the opposite would be true if MAP were equivalent to RPM. Specifically, AB predicts that MAP as a price discrimination device can allow a manufacturer to induce retailers to set different retail prices for the same product. A binding RPM, on the the other hand, should homogenize prices across retailers. We define dispersion as a product's weekly maximum-minimum retail price difference across retailers. Compared with non-MAP products, the MAP product retail price dispersion is higher, consistent with AB. The dispersion is more evident at the beginning of our data (November 2011) and gradually decreases. We also find that the weekly dispersion within a product is almost entirely driven by cross-retailer price differences as opposed to within-retailer, cross-day differences, suggesting a limited role of mixed pricing.

We then further investigate the source of cross-retailer price differences. We show that while most products are available on large retailers (Amazon, BestBuy, and Walmart), MAP products are sold on more niche retailers (such as Newegg). Compared with non-MAP products, the MAP product price difference is larger on niche retailers but smaller on large retailers. We argue that this result may be related to how MAP is enforced.

Finally, we examine how retail prices change after MAP is reduced. We derive a novel prediction from the AB model that, when MAP is reduced to account for declining demand, retail prices may rise and retail price dispersions become smaller due to changes in retail pricing strategies. We find support for both outcomes in our data. This data pattern is hard to rationalize if MAP acts as binding RPM.

There have been relatively few empirical investigations of MAP's effects despite its widespread use.[2] MAP has even spawned a secondary industry that monitors compliance due to the large volume of products covered under MAP, especially in online markets. Is-

[2] AB provides examples of MAP policies in over 40 product categories.

raeli, Anderson, and Coughlan (2016) and Israeli (2018) study the enforcement of MAP and provide evidence that MAP is not a lower bound on retail prices. In addition to confirming this finding, we further contribute to understanding the effects of MAP by providing new empirical evidence that MAP is a price discrimination device and has distinct effects from RPM. Our unique setting allows us to empirically examine the interactions between retail prices and MAP. While this paper does not study how MAP products are chosen or estimate the causal effect of MAP on prices, we find meaningful differences in the pricing of products with and without MAP inconsistent with the implications of RPM.[3] These differences suggest that MAP is not RPM, and antitrust regulators should not confuse their competitive effects.

The rest of the paper proceeds as follows. First, we review the historical legality of MAP in Section 2. In Section 3, we briefly summarize the AB model. In Section 4, we discuss our setting and data. We present our empirical analysis in Section 5. Section 6 concludes.

2 An Overview of MAP's Legality

In the US, the legality of MAP has changed over time. Historically, US antitrust law treated any form of vertical price-fixing—including minimum resale price maintenance (RPM)—as *per se* illegal. The Supreme Court's 1911 decision in *Dr. Miles Medical Co. v. John D. Park & Sons Co.* condemned minimum retail price policy, equating it to a naked price-fixing cartel (drm, 1911). Authorities saw MAP as similarly influencing retail prices and deemed the practice also per se illegal (Federal Trade Commission, 2000). A significant shift occurred with *Leegin Creative Leather Products, Inc. v. PSKS, Inc.* (2007), where the Supreme Court overruled the *per se* ban and held that vertical price restraints like RPM and MAP must be judged under the rule of reason (SCOTUS, 2007). Nowadays, many manufacturers in the US employ MAP to avoid antitrust scrutiny. A MAP policy restricts the advertised price but does not prohibit the retailer from selling at a lower unadvertised price, making it more

[3]Furthermore, our analysis differs from the existing empirical studies of RPM. We are not aware of empirical studies of RPM that directly use data on pricing restrictions from contracts (for a review, see MacKay and Smith, 2017).

defensible than explicit RPM agreements (str, 2020). In addition, MAP asserts unilateral imposition and avoids being construed as "an agreement between multiple parties" that may violate the Sherman Act (Albert, 2011).

The legality of MAP varies across other countries. The European Union treats RPM as an antitrust violation and views MAP as similar to RPM. The European Commission and the Court of Justice of the European Union (CJEU) have consistently interpreted minimum resale price agreements as "restrictions by object" due to their inherent potential to restrict competition, particularly in the context of vertical agreements (ver, 2022; Rosas et al., 2023). The European Commission's Vertical Block Exemption Regulation (VBER) explicitly blacklists RPM, denying it any safe harbor (vbe, 2022). Importantly, a supplier-imposed floor on advertised prices is viewed as equivalent to RPM in effect (Ennis and Kuhn, 2021). The United Kingdom's treatment of RPM and MAP has largely paralleled this approach. The Competition and Markets Authority emphasizes that MAP is an indirect form of the illegal RPM (Competition and Markets Authority, 2016). In Canada, the illegality of MAP requires proof of competitive harm (Competition Bureau Canada, 2022), which is closer to the US approach.

Overall, the legality of MAP is based on that of RPM in many countries. Therefore, it is important to understand whether the two policies indeed have similar effects. In the following analysis, we provide theoretical motivation and empirical evidence that MAP and RPM have distinct effects.

3 Theory

In Section 3.1, we describe the premise of the search model in AB and summarize the main results. Specifically, AB shows that under MAP, it is sometimes optimal for a manufacturer to induce a pure strategy price discrimination equilibrium in the retail market. Then in Section 3.2, we discuss how retailers may change their prices in response to declining demand and the resulting MAP change.

3.1 Pricing Under MAP

A manufacturer sells identical products at zero marginal cost to two retailers. The market for each product consists of a continuum of consumers with unit demand for the product. There are two types of consumers: a high type with willingness-to-pay equal to h and a low type with willingness-to-pay equal to $\ell < h$. A consumer may purchase this good if she visits a store and the retail price is lower than her willingness-to-pay.

Low type consumers observe the retail prices of both retailers and always visit the retailer with the lowest retail price. If the retail prices are the same and equal to or below ℓ, a low type consumer buys from either retailer with equal probability.

High type consumers observe the advertised prices of both retailers and always visit the retailer with the lowest advertised price. These consumers will visit at most one retailer, and they visit either retailer with equal probability if the advertised prices are equal. The high type does not observe retail prices until she visits a retailer, and she makes a purchase only if the retail price is no higher than her willingness-to-pay. We also assume that the high type does not visit the other retailer if the retail price in the visited store is higher than h.

There is a unit-mass continuum of the two types of consumers. The fractions of high and low types are $(1-\lambda, \lambda)$, $\lambda \in [0,1]$. The retailers face the same contract from a manufacturer. The contract consists of a two-part linear tariff with a wholesale price $w \geq 0$, fixed fee $T \geq 0$, and minimum advertised price p^{MAP}. We assume truthful advertising, meaning that retailers do not advertise prices below their retail prices.

The timing is as follows: (1) the manufacturer sets the same contract for each retailer, (2) retailers accept or reject the contract, (3) retailers set their retail prices and advertised prices, and (4) consumers visit stores and decide whether to purchase a product. AB consider the subgame-perfect Nash equilibrium. Below, we summarize the optimal strategies of the manufacturer and the resulting downstream retail prices (Proposition 1 and Corollary 1 in AB):

Proposition 1.

1. *If $\frac{1-\lambda}{1+\lambda}h > \ell$, it is optimal for the manufacturer to set a wholesale price of $w = h$, a*

lump sum payment $T = 0$ *and any* $MAP \in (0, h)$*. Both retailers set a retail price of* h*.*

2. *If* $\frac{1-\lambda}{1+\lambda}h \leq \ell$*, it is optimal for the manufacturer to set a wholesale price of* $w = \dfrac{\ell(1+\lambda) - h(1-\lambda)}{2\lambda}$*, a lump sum payment* $T = \dfrac{(h-\ell)(1-\lambda^2)}{4\lambda}$*, and a MAP of* h*. A retailer sets a retail price of* h *and the other sets a price of* ℓ*.*

In comparison, a manufacturer who cannot impose MAP may set the wholesale price at h to sell only to the high valuation consumers when $(1-\lambda)h > \ell$. Otherwise the manufacturer sets the wholesale price at ℓ to sell to all consumers.

3.2 Testable Implications

We contrast the pricing strategy under MAP with that of RPM. First, MAP does not impose a lower bound on retail prices. Second, MAP enables the manufacturer to induce different retail prices. In comparison, binding RPM tends to homogenize retail prices.

Third, when a manufacturer lowers a binding RPM in response to declining demand, the lowest retail price should (weakly) decrease. We find that the AB model may predict the opposite effect for MAP. In Figure 1, the manufacturer uses MAP to induce different retail prices (strategy 2 in Proposition 1) when consumer valuations (h, ℓ) are in the brown region. When the valuations decrease and cross into the blue region, the manufacturer prefers a uniform retail pricing equilibrium (strategy 1 in Proposition 1). The separation is along the line $\frac{1-\lambda}{1+\lambda}h = \ell$. Suppose the valuations before and after the decrease are (h, ℓ) and (h', ℓ'). The lowest retail price then increases from ℓ to h' when $h > h' > \ell > \ell'$, $\frac{1-\lambda}{1+\lambda}h < \ell$ and $\frac{1-\lambda}{1+\lambda}h' > \ell'$. We discuss the welfare implications in relation to our empirical findings in Section 5.4.

In the next section, we describe the empirical setting and quantify the retail pricing differences between MAP and non-MAP products.

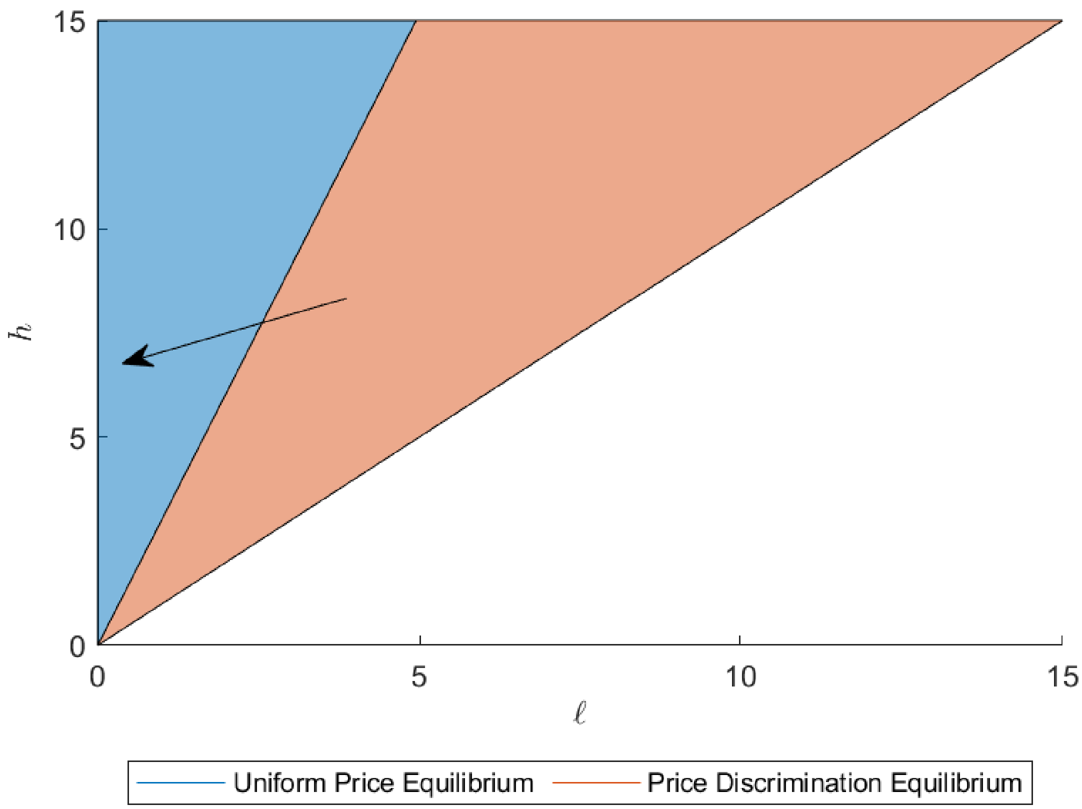

Figure 1: Simulated Phase Transition

4 Background

4.1 Seagate MAP Policies

Seagate Technology is a leading producer of hard disk drives, a billion dollar market (Igami and Uetake, 2020). Since at least 2009, Seagate has imposed a minimum advertised pricing policy on its US retailers. Seagate publicizes this information to retailers through its website.[4] In Figure 2, we display the main features of this policy (red emphasis added by the authors).[5] The policy clearly delineates what qualifies as an advertised price and outlines incentives for compliance with its restrictions. In the online setting, Seagate's definition of covered advertising includes price comparison sites like Google Shopping and the front page of retailer websites like Amazon or eBay. It excludes the shopping cart page(s) of these retailer sites. At the shopping cart page, the policy allows the retailer to set whatever price it chooses. Such stipulation means that a consumer will not see the actual price she will pay until just before she enters her payment information. This requirement can potentially impose significant information frictions to average consumers.

As is typical, Seagate defines the terms and holds unilateral enforcement power. For products that are subject to MAP, resellers found to display a price below the specified level forfeit promotional funds that support advertising. There are 9 Seagate products subject to MAP from November 2011 to April 2013. These products belong to two Seagate product series: Barracuda for workstations and high performance PCs, and Momentus for mainstream laptops and desktops. Other Seagate products, such as SkyHawk, are for more specialized systems (such as surveillance) and differ substantially from the products we consider here.

4.2 Data

For retail prices, we use a dataset from Dynamite Data LLC, a provider of global price and other metrics to e-commerce businesses. To find the true retail prices, the firm simulated the

[4] These policies also contain manufacturer suggested retail prices (MSRP), but publicly available information does not suggest that these Seagate products are subject to RPM.

[5] An example contract is available at `https://econ-chenyu-yang.github.io/seagate-map.pdf`.

Introduction

Seagate's Minimum Advertised Price (MAP) Policy establishes advertised price standards for specified Seagate products. Advertised pricing of Covered Products must comply with this Policy in order to be eligible for Promotional Funds. Seagate will not provide Promotional Funds for advertisements that do not comply with this Policy.

Each reseller is free to independently set its actual resale price for any product.

Figure 2: Seagate MAP Policy

purchase decision through the shopping cart stage. Our dataset contains product prices at daily frequencies from across the largest US online retail websites between November 2011 and April 2013.

We focus on products sold by first-party retailers that contract directly with the manufacturer. As such, we do not consider prices for products available on marketplaces sold through third party agents via distributors. Israeli et al. (2016) show that compliance with MAP is 78%-85% for first party retailers, significantly higher than for third party retailers. There are 11 retailers in the data. Three are large e-commerce websites: Amazon, BestBuy and Walmart. We also observe more specialized or smaller general outlets, which include CDW, Dell, Frys, Insight, Microcenter, Newegg, Rakuten and TigerDirect. In the analysis below, we call the non-Amazon, BestBuy, and Walmart retailers the "small retailers." We call Amazon, BestBuy, and Walmart the "large retailers."

Table 1: MAP Product Characteristics

SKU	Retail Price⋆				MAP⋆	Δ MAP⋆	# MAP Changes	# Retailers⋆
	Mean	25th Perc.	50th Perc.	75th Perc.				
Barracuda 500 GB 7200 3.5	47.54	42.87	45.23	48.75	45.98	-3.20	2	8.82
Barracuda 2 TB SATA 3.5	19.55	17.19	17.64	20.31	18.42	-3.47	3	7.35
Barracuda 2 TB SATA	18.36	16.87	18.28	20.28	18.24	-1.87	3	1.86
Barracuda 3 TB SATA	19.62	16.98	18.61	20.00	18.53	-1.71	5	7.54
Momentus 250 GB Plug-In	77.37	63.99	74.23	83.38	63.99	-	0	5.71
Momentus 320 GB Plug-In	79.03	67.82	79.99	89.95	60.98	-5.00	1	1.91
Momentus 320 GB Internal	71.75	59.99	69.99	74.45	60.31	-5.00	2	7.22
Momentus 500 GB Internal	53.45	44.79	51.19	57.59	52.19	-8.00	2	8.46
Momentus 1 TB LP	30.76	29.68	31.25	31.25	31.25	-1.60	2	8.73

Notes: ⋆ denotes statistics across weeks. Prices, MAP, and Δ MAP expressed in dollars per 320 GB. All observations are at the product-retailer-week level.

Table 1 summarizes the characteristics of MAP products. The per-capacity price is significantly lower for larger drives. The minimum advertised price is similar to the mean retail price, although the distribution of retail prices is relatively dispersed across time and retailers for the same product. Over the approximately two years in our data, one product had five unique MAP changes and seven products had at least two unique MAP changes. In each change, MAP is always decreased, and the average change is about 9% of the retail price.

Table 2 presents the characteristics of non-MAP products. For products with similar capacity and in the same product line as the MAP products, non-MAP product prices are similar and tend to be slightly higher. Overall, non-MAP products are distributed over fewer retailers. Using the page visit history of a subset of comScore panelists who visited Seagate products at the retailers in our sample during November 2018, we find that MAP products receive more visits, suggesting that MAP is more likely to be imposed on flagship products. Unfortunately, this product visitation dataset is not available for our sample period.

Table 2: Non-MAP Product Characteristics

SKU	Retail Price*				# Retailers*
	Mean	25^{th} Perc.	Median	75^{th} Perc.	
Barracuda 160 GB 3.5 SATA	120.40	83.98	135.98	149.98	1.81
Barracuda 160 GB SATA 300	173.01	122.02	197.90	197.90	1.02
Barracuda 250 GB 7200	60.87	60.15	61.43	61.43	1.00
Barracuda ES 2 250 GB	125.35	96.00	96.00	127.99	1.29
Barracuda 400 GB SATA	87.85	89.78	89.78	89.78	1.00
Barracuda 500 GB 7200	59.39	50.84	55.65	75.01	1.02
Barracuda ES 2 500 GB	83.19	83.19	83.19	83.19	1.00
Barracuda ES 500 GB	68.23	63.10	68.95	72.23	1.61
Barracuda 1 TB SATA 3	29.03	25.00	28.12	31.25	7.63
Barracuda SAS 1 TB 7200	79.13	53.74	68.73	109.36	1.79
Barracuda 1.5 TB Desktop	22.69	20.52	21.87	23.33	4.95
Barracuda Green 1.5 TB	19.73	16.66	20.42	22.71	3.00
Barracuda 2 TB	18.83	16.22	17.20	18.75	7.33
Barracuda 2 TB SATA 3 5900	17.90	15.62	17.66	18.75	3.28
Barracuda 2 TB SATA 3 7200	9.71	9.37	9.37	10.15	1.00
Barracuda 7 3 TB	17.54	15.62	16.67	18.74	6.73
Barracuda Green 3 TB	62.50	62.50	62.50	62.50	1.00
Barracuda 4 TB SATA 3	15.64	14.84	15.00	16.01	4.40
Momentus Mobile 160 GB 7200	137.61	89.98	110.00	179.98	1.03
Momentus 5400 250 GB	75.26	63.77	63.99	64.49	1.83
Momentus 320 GB Thin SATA	82.34	78.99	79.99	85.99	3.72
Momentus 500 GB 2.5 Internal	52.39	45.04	51.19	57.59	5.82
Momentus 500 GB Thin	42.74	39.67	42.87	44.79	5.73

Notes: $\star$ denotes statistics across weeks. Prices expressed in dollars per 320 GB. All observations are at the product-retailer-week level.

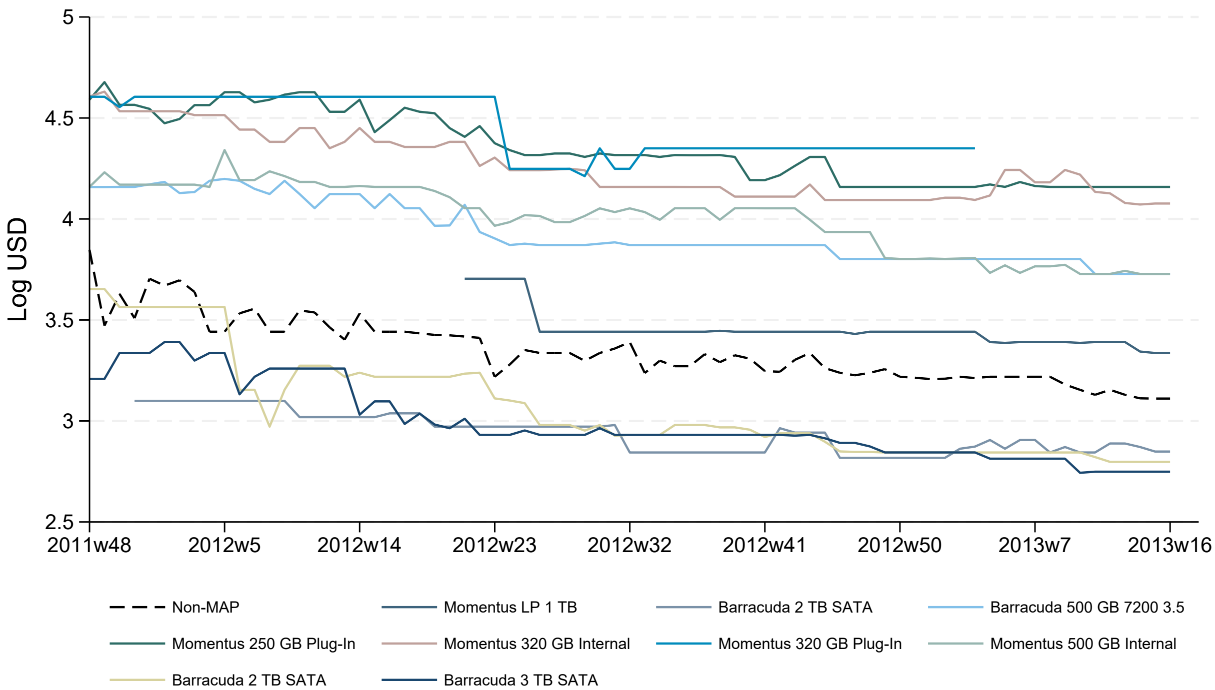

Figure 3: Median Prices Over Time: Non-MAP and MAP Products

Notes: Prices are measured in dollars per 320 GB before logging. Observations are at the product-retailer-week level. Within each week, the median retail price for each MAP product is plotted. The median retail price across all non-MAP products is plotted.

Figure 3 shows the price trends of products during our sample period. This pattern is consistent with declining demand of technology products over time (Gordon, 2009; Gowrisankaran and Rysman, 2012). It is also possible that some of the price decrease over time resulted from increased HDD factory capacity, as several major factories were impacted by flooding in Thailand in 2011 (including those of Seagate) (Hydro and Agro Informatics Institute, 2011). Our results in the paper are based on a sample that starts after the flooding itself largely subsided, and they are robust to using a shorter sample that starts in June 2012.

5 Empirical Analysis

5.1 MAP is Not a Retail Price Lower Bound

We start by showing that the MAP, unlike RPM, does not impose a lower bound on retail prices. Table 3 shows the share of retailer-week observations where the weekly average retail prices fall below MAP. The violations occur for all but one MAP product. Overall, the retail prices are lower than MAP in 41% (1,631 of 3,959) of product-retailer-week combinations, and the percentages are greater than 50% for 2 of the 9 products subject to MAP.

We also note that the violations are not likely due to lax enforcement. Firms such as our data provider conduct daily advertised and retail price reports. Then the manufacturer can withhold advertising promotional funds as punishment for violating the terms of MAP. These promotional funds may be particularly important for smaller retailers. Had MAP imposed a retail price lower bound, we would have expected smaller retailers to violate the lower bound less frequently. Therefore, in the last column of Table 3, we compute the share of retailer-week observations where retailer prices are below MAP on small retailers. The shares are only slightly lower than the results using all retailers for most MAP products, which suggests that MAP is not likely a retail price lower bound even on small retailers.

We also find that retail prices are less likely to fall below MAP at the beginning of the sample when retail prices are higher, although the discount below MAP is larger. Figure 4 shows the percentage of product-retailer pairs in a given week where the retail prices are below MAP, $5 below MAP, and $10 below MAP. These patterns persist over long periods of time and across products, suggesting that setting retail prices below MAP is not a chance event.

5.2 MAP Products have Higher Price Dispersions

We next compare the price dispersion of MAP and non-MAP products over time. Price dispersions shed light on how MAP differs from RPM. Under binding RPM, product prices should be stable over time and more homogeneous across retailers. In contrast, an upstream

Table 3: Percentage of Time Retail Prices Fall Below MAP

SKU	% Price < MAP (1)	% Small Retailer Price < MAP (2)
Barracuda 500 GB 7200 3.5	33.53	27.07
Barracuda 2 TB SATA 3.5	46.83	35.38
Barracuda 2 TB SATA	46.53	20.00
Barracuda 3 TB SATA	55.75	51.58
Momentus 250 GB Plug-In	35.26	24.38
Momentus 320 GB Plug-In	0.00	0.00
Momentus 320 GB Internal	1.42	1.59
Momentus 500 GB Internal	43.92	41.67
Momentus 1 TB LP	81.86	76.61

Notes: Table displays the percentage of product-retailer-week-level observations where the retail price is below MAP across all product-retailer-week-level observations for each MAP product. Column (1) pools across all retailers, while column (2) restricts to small retailers only.

manufacturer in the AB model may structure contracts such that retailers set different prices under MAP, resulting in a higher degree of price dispersion.

Given a product and a week, our measure of price dispersion is the difference between the logged highest and lowest retail prices in a week. Figure 5 presents the time series of the average dispersion measure by product type across all product-week combinations, where a product is available on at least two retailers in the same week. The non-MAP products include all Barracuda and Momentus products not subject to MAP. MAP product retail prices, particularly in the earlier part of our sample, are much more dispersed than non-MAP product prices. MAP and non-MAP product price dispersions converge towards the end of our sample, consistent with decreasing consumer heterogeneity in addition to willingness-to-pay over time.

Furthermore, the dispersion differences are not driven by over-time, within-retailer price differences. Figure 6 attempts to decompose the within-week-retailer price variation from the overall price variation. Specifically, we first compute the variance in daily prices for a product-retailer pair within each week. We then plot the average variance across all such pairs over weeks. This measure represents the decomposed variance for prices within a

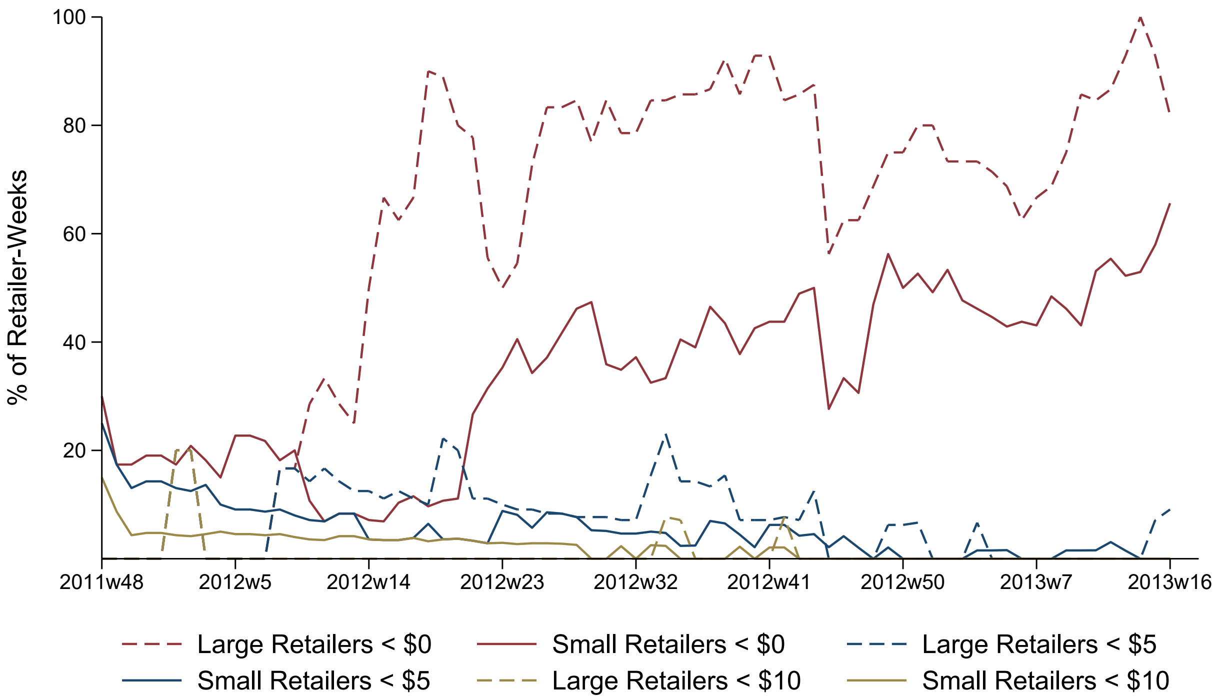

Figure 4: % of Retailer-Weeks with Retail Prices $<$ \$0, \$5, and \$10 Below MAP by Retailer Type Over Time

Notes: Plots the percentage of product-retailer-week-level observations where each retail price is \$0, \$5, and \$10 below MAP by retailer type (i.e., large vs. small retailers) and week.

product-retailer pair (Within). We also compute the variance of daily prices across retailer-day pairs for a product in each week. We then plot the average across all products over weeks. This measure includes the price variation across retailers (Between). We find that the Between variance is magnitudes greater than the Within variance, and the Between variance is higher for MAP products. This result suggests that cross-retailer heterogeneity is the main source of price variation for both types of products, and the price variation across retailers is higher for MAP products.

We next more formally quantify the average difference in dispersion and the source of dispersion differences. We divide our sample into small and large retailer sub-samples. In the first column of Table 4, we regress the price dispersion measure for a product-retailer pair on a MAP indicator, controlling for week, retailer, and product characteristic fixed effects, including the capacity, speed, and form factor. We find that there are no meaningful differences between MAP and non-MAP products, suggesting the price dispersion difference is not driven by the over-time, within-retailer price variations in a week.

The second column shows that the dispersion differences between MAP and non-MAP products are driven by retailers setting different prices. We repeat the same regression in column (1) on the sample of all product-week pairs, but where the outcome variable is defined as the maximum price difference across retailers for a product and a week. We also do not include retailer fixed effects. We find that MAP retail prices are 7.2% more dispersed than non-MAP products on small retailers. In contrast, MAP product prices are less dispersed on large retailers, consistent with the interpretation that MAP may be more effectively enforced on small retailers. In column (3), we find similar dispersion differences without week fixed effects, which suggests that dispersion differences are not driven by over-week price variations either. The price stability over time also suggests a limited role for mixed pricing strategy.

5.2.1 Selection and Endogeneity

There may be two alternative explanations for the findings. First, retailers facing different demand may adopt different pricing strategies. Using a dataset from comScore that tracks website visits of a sample of consumers from 2011 to 2013, Amazon accounts for 71.24% of visits to retailers in our data, and Amazon, Walmart and BestBuy collectively account for 92.89% of all visits (Table A.1 in the Appendix). However, our results are more consistent with the interpretation that MAP enables price discrimination mainly on small retailers. Importantly, we find that price dispersions are different between MAP and non-MAP products even on the same small retailer. Furthermore, in Appendix Table A.2, we estimate the price differences between MAP and non-MAP products across each pair of retailers, controlling for retailer-pair fixed effects. We similarly find that dispersion is greater for MAP products on small retailers.

Another potential explanation is that a manufacturer is more likely to impose MAP on a product when its potential consumers do not search intensively for retail prices and rather

Table 4: MAP Impact on Average Price Dispersion by Week and Retailer Type

	Intra-Retailer (1)	Inter-Retailer (2)	Inter-Retailer (3)
Panel A: All Retailers			
$\mathbb{1}$(MAP)	-0.001	0.066***	0.063***
	(0.002)	(0.011)	(0.012)
N	7,334	1,210	1,210
R^2	0.052	0.318	0.186
Panel B: Small Retailers			
$\mathbb{1}$(MAP)	0.000	0.074***	0.072***
	(0.002)	(0.011)	(0.012)
N	5,838	1,016	1,016
R^2	0.061	0.361	0.235
Panel C: Amazon, Best Buy, Wal-Mart			
$\mathbb{1}$(MAP)	-0.009	-0.097***	-0.159***
	(0.006)	(0.037)	(0.044)
N	1,496	356	366
R^2	0.111	0.419	0.178
Fixed Effects			
Week	Yes	Yes	No
Retailer	Yes	No	No
GB Capacity	Yes	Yes	Yes
RPM	Yes	Yes	Yes
Disc Size	Yes	Yes	Yes

Notes: Observations in column (1) are at the product × retailer × week level. Observations in columns (2) and (3) are at the product × week level. In column (1), the dependent variable is the maximum log price less the minimum log price for a product within a retailer-week. In columns (2) and (3), the dependent variable is the maximum log price less the minimum log price for a product within a week across all retailers. Heteroskedasticity-consistent standard errors in parentheses and clustered at product level. Reference group is composed of all non-MAP Barracuda and Momentus products. Levels of GB capacity are: 250, 320, 500, 1,000, 1,500, 2,000, 3,000, and 4,000. Levels of RPM are: 5,900 and 7,200. Level of disc size is: 3.5. *** indicates significance at the 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.

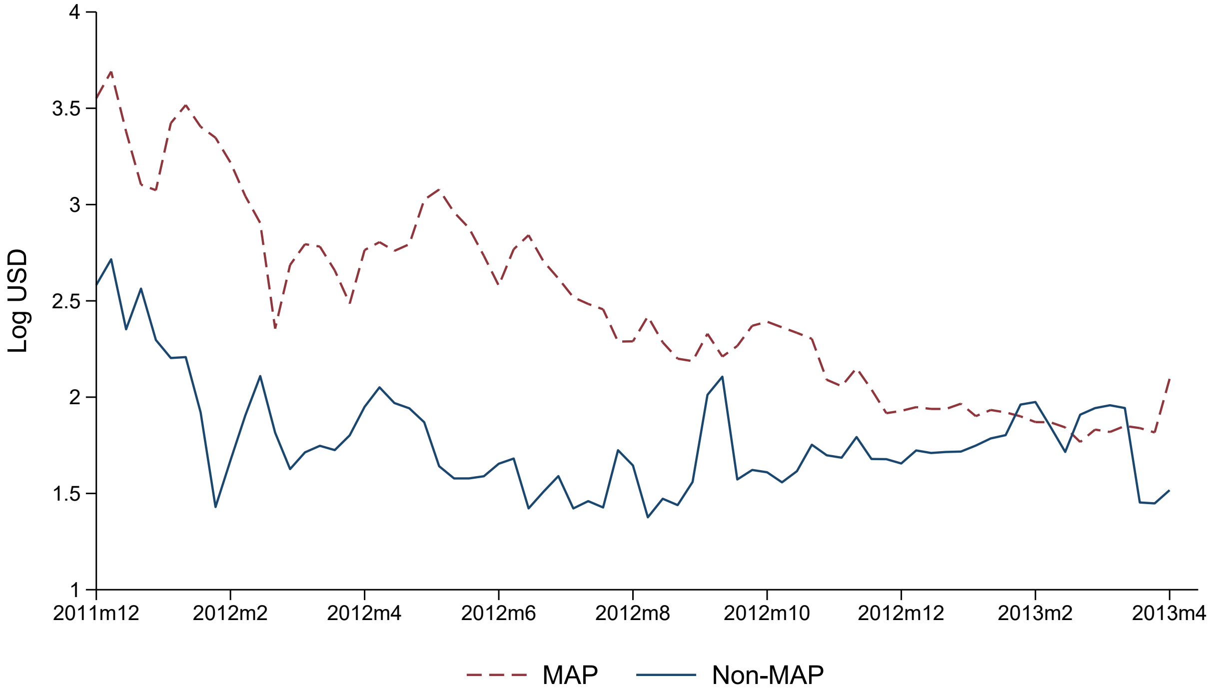

Figure 5: Within Week Average Price Dispersion by Product Type

Notes: Plots the average in log(maximum price) - log(minimum price) across retailers for each product-week by product type.

rely on advertised prices to decide whether to visit a store. We do not think this is the main driver of selection into MAP. As we explained in Section 4.2, MAP products are likely better promoted and may have higher sales, but it is not obvious that their consumers are less likely to search for retail prices across different online retailers. It is more likely that MAP is imposed on select (flagship) products to reduce administrative costs. Therefore, our preferred interpretation is that the data pattern suggests differences in pricing strategy as opposed to selection.

Finally, these results show a key distinction between MAP and RPM. A binding RPM should increase the price stability of the products across retailers. Should MAP be equivalent to RPM, our regressions would show that the dispersion is smaller for MAP products. We therefore see these results as evidence that MAP is not RPM.

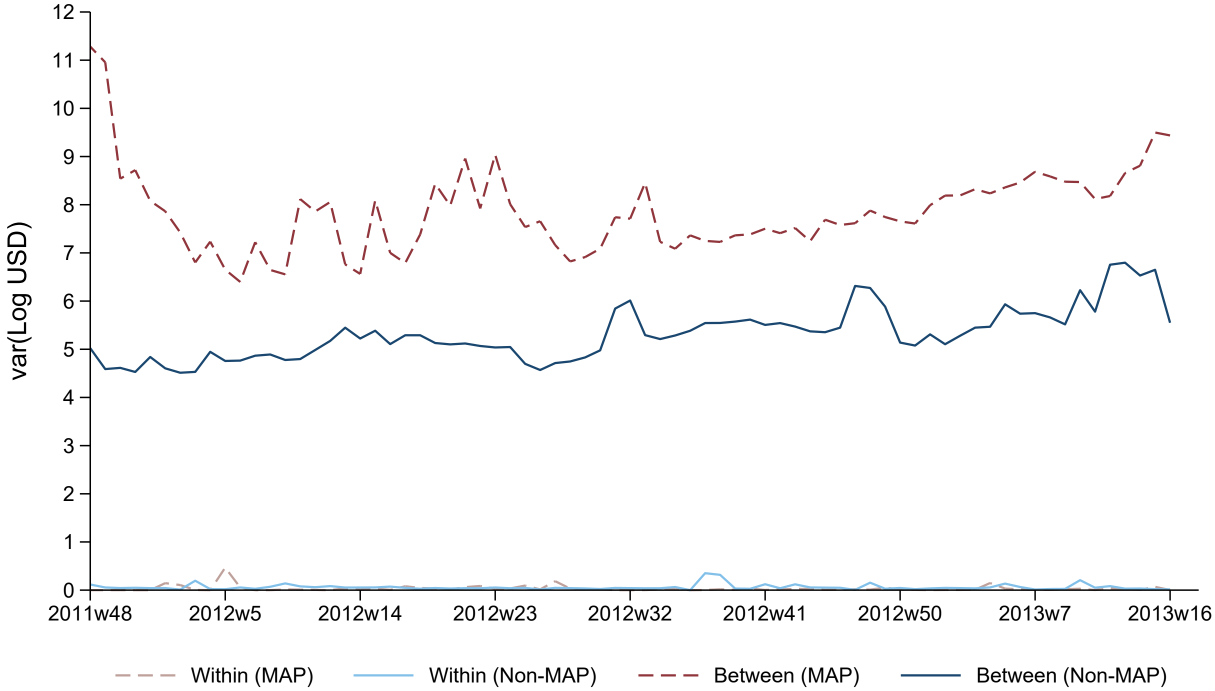

Figure 6: Within-Retailer vs. Between-Retailer Variance Decomposition by Product Type and Week

Notes: Plots the average variance in prices for a product within a retailer by week and across retailers by week across product types.

5.3 Retail Prices After A MAP Decrease

We now turn to a counter-intuitive implication of the theoretical model where a decrease in MAP may be followed by an increase in retail prices. This prediction contrasts with the implication of RPM, where a decrease in binding RPM should lead to (weakly) lower retail prices. Therefore data patterns consistent with an increase in retail prices after MAP decrease show that MAP differs from RPM. We note that all minimum advertised prices are reduced on Seagate's hard disk drives during our observation period, consistent with the explanation of declining demand for technology products and the retail price trends in Figure 3.

We estimate the effects of MAP decrease using the approach of de Chaisemartin and

Table 5: Effect of MAP Decrease on Average Intra-Week Price Dispersion and Minimum Price

	Price Dispersion (1)	Minimum Price (2)
$\overline{\beta}_d$	-0.149***	0.114***
	(0.021)	(0.020)
Fixed Effects		
Week	Yes	Yes
Product	Yes	Yes
N	112	112

Notes: Observations are at the product × day level. The y variables are the maximum difference in logged per 320GB prices and minimum logged price of a product across retailers. Heteroskedasticity-consistent standard errors in parentheses and clustered at the product level. Average β_d post MAP decrease in eq. (1) displayed. *** indicates significance at the 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.

Table 6: Effect Heterogeneity of MAP Decrease on Average Intra-Week Price Dispersion and Minimum Price

	< 7% MAP Decrease		> 7% MAP Decrease	
	Price Dispersion (1)	Minimum Price (2)	Price Dispersion (3)	Minimum Price (4)
$\overline{\beta}_d$	-0.142***	0.101***	-0.161***	0.132***
	(0.025)	(0.018)	(0.046)	(0.048)
Fixed Effects				
Week	Yes	Yes	Yes	Yes
Product	Yes	Yes	Yes	Yes
N	96	96	88	88

Notes: Observations are at the product × day level. The y variables are the maximum difference in logged per 320GB prices and minimum logged price of a product across retailers. Heteroskedasticity-consistent standard errors in parentheses and clustered at the product level. Average β_d post MAP decrease in eq. (1) displayed. *** indicates significance at the 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.

D'Haultfœuille (2020) and de Chaisemartin et al. (2022). We focus on the MAP decrease on March 3rd, 2013, when Seagate reduced MAP on 5 products. Specifically, one typically estimates cohort-time-specific treatment effects when treatment is staggered, and aggregates them into a single average effect (see, e.g., Callaway and Sant'Anna, 2021; Goodman-Bacon, 2021; Sun and Abraham, 2021). We therefore use this one event because other events have too few products with MAP decreases to identify their effects. We estimate the following event study specification:

$$\begin{aligned} y_{it} = \alpha + \sum_{d=-3}^{8} \beta_d \text{Treat}_{it} \times \mathbb{1}[t = d]_t + \sum_{d=-3}^{8} \phi_d^1 \text{MAP}_{i(-3)} \times \mathbb{1}[t = d]_t + \\ \sum_{d=-3}^{8} \phi_d^2 \text{MAP}_{i(-3)}^2 \times \mathbb{1}[t = d]_t + \gamma_i + \tau_t + \epsilon_{it}. \end{aligned} \tag{1}$$

We have two outcomes of interest y_{it}. Our first is the maximum difference in logged prices for product i on day t. Our second outcome of interest is the minimum price of product i on day t across all retailers. Our coefficients of interest β_d are on the interactions between whether product i is subject to MAP and a time indicator for each of the three days pre-MAP change and eight days post-MAP change.[6] To use the event study estimator of de Chaisemartin and D'Haultfœuille (2020), the treatment variable Treat_{it} is a binary indicator for whether MAP is reduced. To estimate the average treatment effect, we follow de Chaisemartin et al. (2022) and include interactions of treatment period fixed effects and a polynomial in the baseline values of MAP as control variables. The coefficients ϕ_d^1 and ϕ_d^2 are on the linear and quadratic terms, respectively. The MAP reductions for the 5 products are \$5, \$3.20, \$1.07, and \$0.80 ($\times$ 2 products) per 320 GB, respectively. These correspond to MAP reductions of 8.3%, 7.1%, 6.3%, and 4.5% ($\times$ 2 products), respectively. We include product γ_i and day τ_t fixed effects as well. We restrict our sample to all Barracuda and Momentus products available at two or more retailers within the week of the MAP decrease.

Average effects are presented in Table 5. Following a reduction in MAP, average intra-day price dispersion among MAP products declines by 13.8%, while the average increase in

[6] The pattern is similar under other time windows.

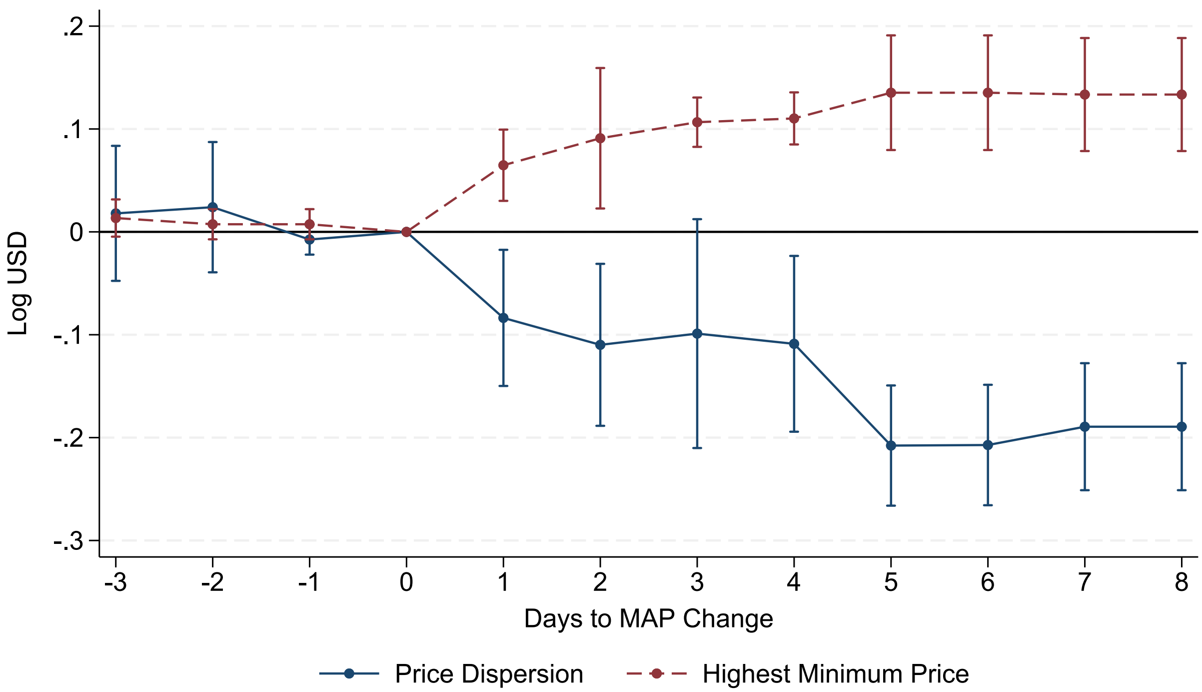

Figure 7: Effect of MAP Change on Price Dispersion and Lowest Retail Price

Notes: Plots main de Chaisemartin and D'Haultfœuille (2020) event study coefficients.

minimum prices is 12.1%. Figure 7 plots the estimates of the MAP decrease for both of our outcomes of interest. Following MAP decreases, the lowest price of a product across retailers increases and a product's price dispersion across retailers falls. This is consistent with the interpretation that a MAP decrease triggered by a demand decrease could lead to a change in the retail price equilibrium, where a retailer that previously set a low price raises its price. At the same time, we find almost no changes in the highest price of a product across retailers after the MAP decrease.

As robustness, we separate the products with MAP into two groups, where one group's MAP change is greater than 7% of the retail price and the other is below. The subsample results (with the same control group as the baseline) shown in Table 6 are similar to those in Table 5. For products with MAP reductions less than 7% of the original MAP, intra-day price dispersion declines by 13.2% on average and minimum prices increases by 10.6% on average. Similarly, for products with MAP reductions greater than 7% of the original MAP, intra-day price dispersion declines by 14.9% on average and minimum prices increased by 14.1% on average. A two-way fixed effect specification also shows a similar result.

Overall, we see this data pattern as additional evidence that MAP is not RPM. Under binding RPM, the relaxation should lead to a decrease, as opposed to an increase in retail prices.

5.4 Welfare Implication

Proposition 1 from AB implies that MAP can improve welfare through price discrimination. Specifically, high valuation buyers could potentially benefit from visiting a low-price retailer. When $\frac{1-\lambda}{1+\lambda}h \leq \ell \leq (1-\lambda)h$, the manufacturer would set a high wholesale price, which would result in high retail prices absent MAP. Otherwise, the manufacturer would set a lower wholesale price to induce one retailer to set a lower retail price under MAP, increasing the total surplus. This result is intuitive, as quantity expands under the MAP-enabled price discrimination. The results in our study are consistent with MAP policies enabling price discrimination, but the lack of quantity data does not permit us to estimate consumer preferences or directly evaluate MAP's welfare effects.

6 Conclusion

We use online retail prices of Seagate hard disk drives to document empirical facts about the minimum advertised price policy. We present three findings suggesting that MAP is not equivalent to RPM. First, MAP does not impose a lower bound on retail prices. Second, MAP product prices are more dispersed than products not subject to MAP. Third, some retail prices increase and product price dispersion may fall after a MAP decrease. In a search model, we find natural explanations for these facts when we interpret the MAP policy as an information restraint that enables price discrimination.

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A Additional Figures and Tables

Table A.1: Share of Site Visits in comScore Data

Retailer	% Share
Amazon	71.240
Walmart	15.050
Best Buy	6.600
Dell	3.200
Newegg	1.930
TigerDirect	0.990
Frys	0.470
Rakuten	0.210
Microcenter	0.210
CDW	0.080
Insight	0.030

Table A.2: MAP Impact on Average Pairwise Inter-Retailer Price Dispersion by Week

	(1)	(2)	(3)
$\mathbb{1}$(MAP)	0.003*	-0.011***	-0.007**
	(0.002)	(0.003)	(0.003)
Both Retailers $\in$ {Amazon, Best Buy, Wal-Mart}		0.044**	
		(0.019)	
Both Small Retailers		-0.024***	
		(0.003)	
$\mathbb{1}$(MAP) $\times$			
Both Retailers $\in$ {Amazon, Best Buy, Wal-Mart}		-0.072***	-0.053***
		(0.019)	(0.018)
Both Small Retailers		0.028***	0.016***
		(0.003)	(0.004)
RPM =			
5,900	-0.052***	-0.089***	-0.056***
	(0.006)	(0.006)	(0.006)
7,200	-0.011***	-0.015***	-0.011***
	(0.003)	(0.003)	(0.003)
Disc Size =			
3.5	-0.008**	0.000	-0.009**
	(0.003)	(0.003)	(0.003)
GB Capacity =			
250	0.070**	0.110***	0.075**
	(0.029)	(0.029)	(0.029)
320	0.058**	0.100***	0.063**
	(0.029)	(0.029)	(0.029)
500	0.067**	0.102***	0.073**
	(0.029)	(0.029)	(0.029)
1,000	0.046	0.074**	0.052*
	(0.029)	(0.029)	(0.029)
1,500	0.095***	0.125***	0.097***
	(0.029)	(0.029)	(0.029)
2,000	0.097***	0.128***	0.102***
	(0.029)	(0.029)	(0.029)
3,000	0.088***	0.118***	0.092***
	(0.029)	(0.028)	(0.029)
4,000	0.091***	0.116***	0.097***
	(0.029)	(0.030)	(0.029)
Fixed Effects			
Week	Yes	Yes	Yes
Retailer Pair	Yes	No	Yes
N	24,300	24,309	24,300
R^2	0.246	0.169	0.248

Notes: Observations are at the product × retailer pair × week level. Heteroskedasticity-consistent standard errors in parentheses and clustered at product level. Reference group is composed of all non-MAP Barracuda and Momentus products. Reference category in column (2) are retailer pairs where one retailer is in the set {Amazon, Best Buy, Wal-Mart} and the other retailer is a small retailer. *** indicates significance at the 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.